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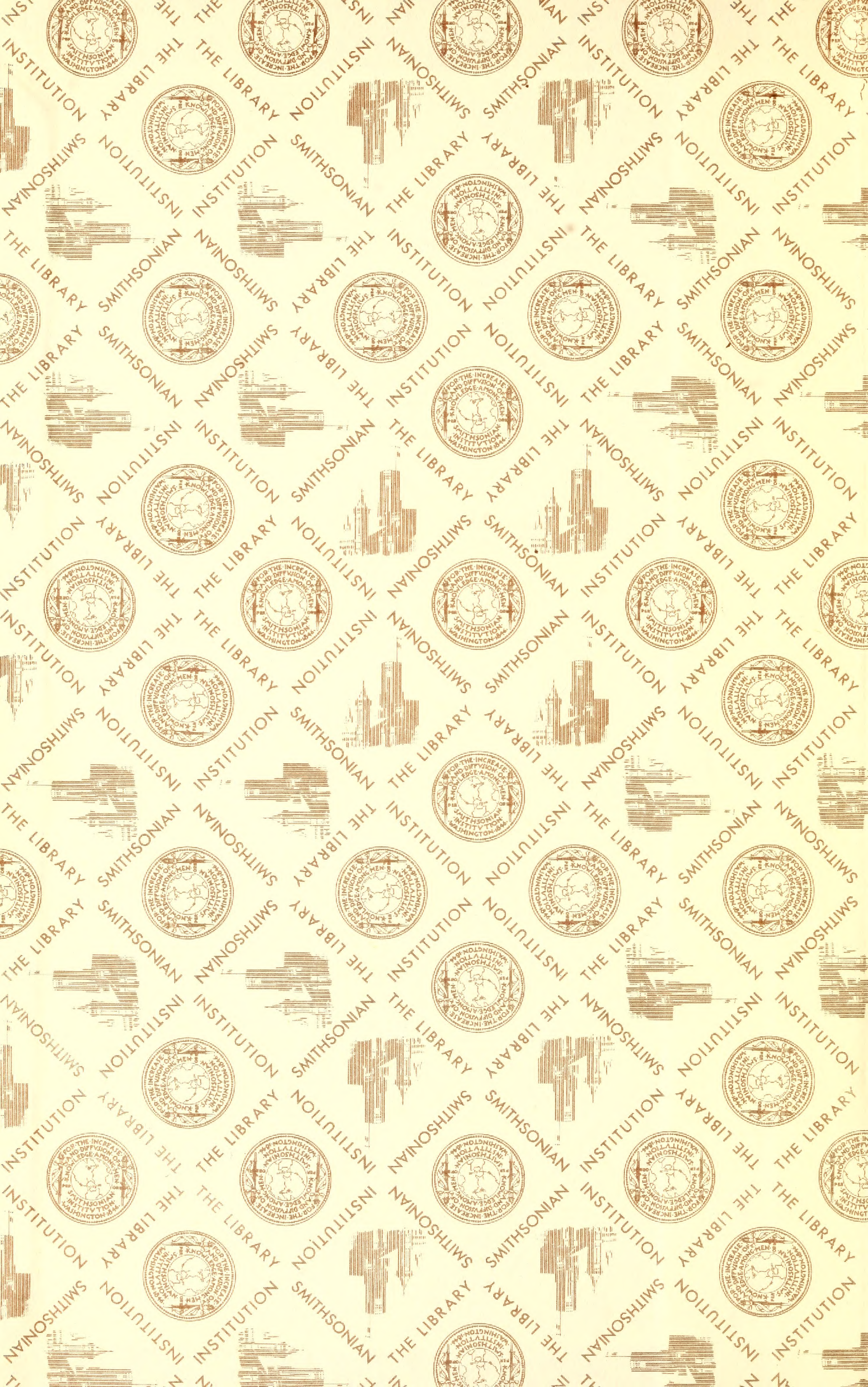

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Journal of the Bombay Natural History Society

Vol. 57, No. 1

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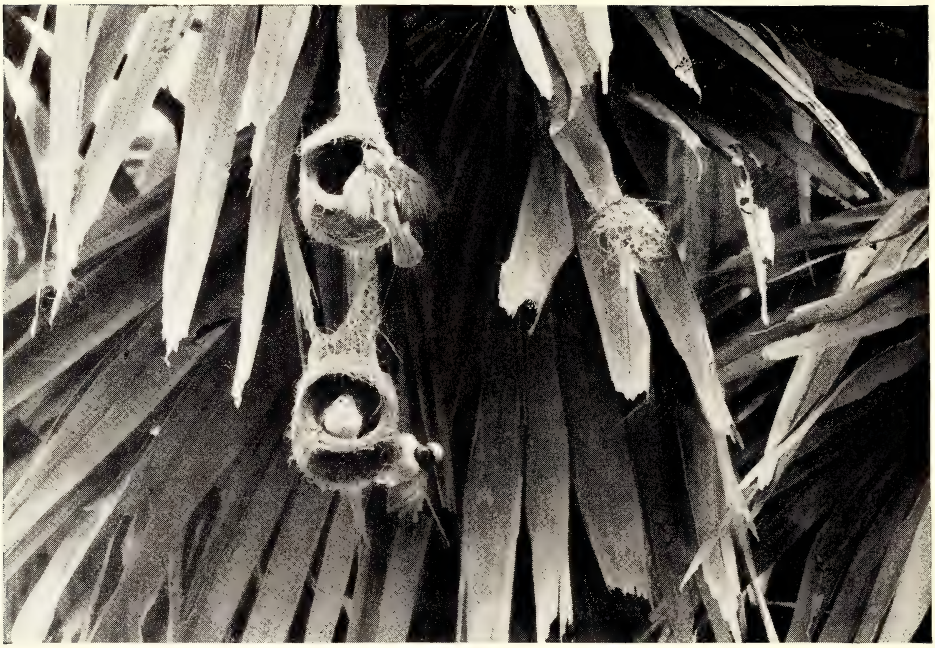
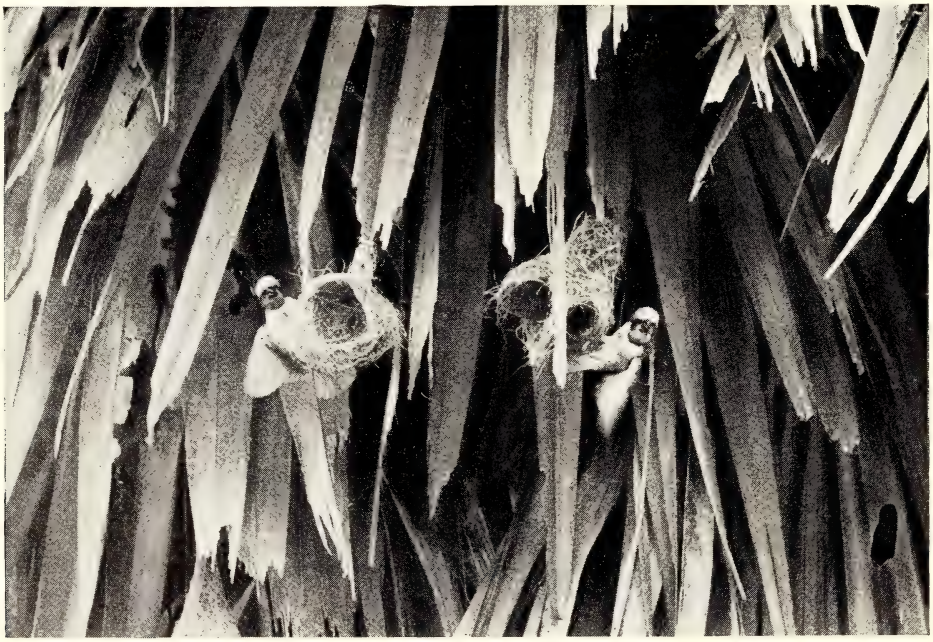


Arrival of prospecting female at helmet nest (lower). Top right : Initial "wad" stage.



Cocks advertising at pre-helmet stage nests.

Photos : Sálim Ali

JOURNAL
OF THE
BOMBAY NATURAL
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1960 APRIL Vol. 57 No. 1

Studies on the Reproductive Behaviour of the Baya Weaver [*Ploceus philippinus* (L.)]

BY

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(*With one plate, one text-figure, and three diagrammatic schemes*)

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I. INTRODUCTION

The present paper is a continuation of studies on the biology of the Indian weavers initiated by Dr. Sálim Ali in 1930 and resumed in 1953 (Ali & Ambedkar 1956, 1957, Ambedkar 1958, in preparation). It is also part of a programme of research on the ethology and social organisation of the Ploceinae started at the Ornithological Field Station of the Department of Zoology, Madingley, Cambridge, in 1954. Observational methods used in West Africa in 1955 and 1956 have been employed in India so that accounts of the behaviour of species in both the Ethiopian and Oriental regions may be directly and precisely compared (See Crook 1958, 1959, 1960, in press : *a*, *b*).

The Baya Weaver (*Ploceus philippinus*) is a polygamous species whose life history and general behaviour have been well described (Ali 1930, Ali and Ambedkar loc. cit.). In the Bombay and Poona areas it breeds in the monsoon season siting its nest colonies typically either in tall palms, usually over water, or in vegetation hanging over deep wells. Occasionally small colonies may be found in trees without protection from water but such sites are decidedly infrequent. The male establishes and defends one or two nests, constructing them as far as the ' helmet stage '[1] (Ali 1930, Crook 1960) at which they are maintained until, following a courtship involving much ' nest advertisement display ' and mutual antagonism, they are accepted by females. The male may have up to three wives whom he acquires successively in a very short period.[2] Details of clutch size, hatching success, mortality, growth rate of young, and fledgeling success have been studied in part (Ali & Ambedkar loc. cit., Ambedkar 1958) and the work remains in progress.

In this paper certain new observations made during the 1958 and 1959 seasons are described and, in particular, a detailed account is given of the territorial and sexual behaviour of the species together with a brief analysis of the data.

1. Methods

Detailed observations from hides, through 8 × 30 binoculars and a × 20 telescope, were made at several wild nesting colonies around Poona, particularly those at Hingane, Parbati Hill, and near the Agricultural College. The changes in behaviour of the weavers are most rapid and in order to obtain a high degree of accuracy an EMI field tape recorder was used in making commentaries on the sequences of behaviour observed. Such commentaries provide the basis for the quantitative data found in the Schemes[1] and described in the text. The recorder was also used in taping the song and cries of the species which will be later analysed by sound spectrograph at Cambridge and used in a comparative study of the vocalisation of the sub-family. A number of simple experiments were made in which nest positions etc. were modified in order that certain aspects of territorial behaviour might be revealed. The results of a programme of nest mutilation experiments will be published separately.

---

[1] The terms referring to stages in nest construction have been used in previous publications (Ali 1930, Ali and Ambedkar loc. cit., and Crook in press *a*). They are (i) Wad—the first bunch of strands woven into a nest site, (ii) the Initial Ring—the ring that develops from the wad, (iii) the Helmet Stage Nest—the roof flange projects both before and behind the initial ring from above, (iv) the Completed Egg Chamber—egg chamber complete but no tube, (v) complete nest and lengthening tube present.

[2] V. C. Ambedkar reports a single case of 5 females to a male in 1959 at Poona.

2. The colony sites

The types of site chosen by the birds for their breeding colonies are shown in Table I. Of 35 colonies 29 (i.e. 82.8 %) were situated over water and of these 23 (i.e. 65.7 % of the total) were hanging either within wells or in trees over them. Only 6 active colonies and occasionally small groups of adults and colonies of juveniles with unoccupied nests were found away from water. In Kumaon several colonies in bhabar country were also located in small thorny bushes without water near them but in the terai most colonies were again hanging over pools or streams.

A fair amount of polemic has centred around the survival value of the siting of weaver colonies over water. Very similar sites are used by certain colonial species in Africa. Lack (1954) supports the argument that ' colonial nesting is possible only for species which are comparatively safe from nest predators, which otherwise would be attracted to the spot '. The sites of avian breeding colonies are normally protective, at least against crippling predation, and the case of cliff-dwelling sea birds is particularly to point here. In the colonial weavers the chosen sites normally appear to be protective either through association with tribal villages (e.g. *Ploceus cucullatus* in West Africa), through breeding in dense thorny bushes, e.g. the *Quelea* in Senegal, (Crook in press *a*), or through siting over water. Actual observations of predators failing to obtain their prey as a result of these factors are relatively few (Crook 1958, 1960) ; but the fact that there are such accounts does indicate that predators do attempt to enter the nests and that they do fail. The main dangers to a Baya colony are crows (*Corvus splendens*, Ali 1956, and also almost certainly *Corvus macrorhynchos* in the Poona area) which bore holes in the nests and feed on eggs and young, and also the nocturnal tree mouse, *Vendeluria oleracea*, which may destroy a brood and establish its nest within that of the Bayas (Ali & Ambedkar 1956). However, this species also builds nests and has young in old nests prior to the reoccupation of the colony in spring so that its breeding is not dependent upon a fresh nest. Against these dangers the Bayas have little protection, though the crows' entry to the colony occasions great excitement and mild mobbing. The Striped Squirrel (*Funambulus palmarum* and *F. pennanti*), certainly a potential predator of eggs, which inhabits the vegetation of wells never climbs out on the dangerously fine twigs from which the Bayas suspend their nests. V. C. Ambedkar (personal communication) has a magnificent account of a snake which was observed on a Baya's nest hanging over the water and attempting to find an entrance. The snake seemed to find difficulty in gripping the nest which contracted under pressure. It edged its way down and tried to get in the tube. However, at this point, it slipped and fell into the well. This provides good evidence not only for the protective value of the siting but also of the nest form itself.

---

[1] For Schemes see pp. 42-44 below.

TABLE I

Sites of breeding colonies of *Ploceus philippinus* in the Poona area 1958 and 1959.

Site	No. of colonies observed	Percentage of total number of colonies
Tall palms over water	2	5.70
Trees overhanging streams	3	8.55
Tree projecting from cliff over stream	1	2.85
Trees over wells	5	14.28
Vegetation hanging within wells	18	51.42
Trees on steep bank away from water	1	2.85
Trees/bushes not near water	3	8.55
Small tree in garden near house	2	5.70
TOTAL	35	..

The Bayas are also extremely particular about the siting of the actual nest. Fine down-hanging twigs are normally used and the resulting nest is well separated from near-by prominences upon which predators might perch while opening it. Further, all projections, such as leaves and leaf bases on the supporting twig, are meticulously plucked off leaving the whole support and the nest surface as bare as possible. This could be a factor preventing predators, such as snakes, getting a grip on the support or alternatively it may reduce the surface area thus lessening sway in winds. This latter point is, however, hardly relevant to nests within the shelter of wells.

It thus appears that both the siting of whole colonies and of individual nests are usually appreciably protective against potential predators. Nevertheless the fact that 17.1% of all the colonies found did not appear to be in a protective site is of obvious significance. Most of these cases were found in the upland area near Karakwasla away from the river valleys and where there are no wells or deep surface streams. It appears then that, where protective sites are not available, the weavers can and do breed without them. It is not known what effect this has on survival. One may suppose that the type of site most common in any one area represents a ' tradition ' of site selection in the Baya population brought about by the selection of the most successful (i.e. most protective) sites in the course of many generations.

3. Polygamy and numbers of nests per territory

The male Baya normally pairs with several females whom he establishes successively in the helmet stage nests prepared for their inspection. Assuming that the ratio of males to their nests in the colonies is taken from a representative sample of all adult birds, Ali & Ambedkar (1956, 1957) have concluded that the tertiary sex ratio is therefore 1 male : 2 to 3 females. This ratio excludes the large population of males in their first year which neither attain adult plumage nor breed successfully till their second year. Females of the first year mate and breed successfully.

During Phases II and III of the breeding season in 1958 (see p. 21) the numbers of females paired to a male were studied in relation to the number of nests the male had built and was maintaining in a fresh condition at the time. The results are given in Tables II and III. The majority of males were mated to a single female (53.6% of total territories examined), a fair number (34.1%) to two females, and very few birds (7.3%) to three females. Further, two territories were noted in Phase III in which the males still hopefully maintained helmet stage nests which no females had occupied. In no case did a male complete a nest that was not occupied by a female. In 78% cases a helmet stage nest was maintained in addition to completed nests. The mean number of both completed nests and females per territory was 1.13 (15 territories and 17 females) at Hingane, 1.5 (16 territories and 24 females) at the Parbati Hill area, and 1.8 (10 territories and 18 females) at the Agricultural College. The mean for all the territories examined is 1.44, thus giving a lower tertiary sex ratio in the breeding colonies than previously supposed. The numbers of structures maintained by males in their territories irrespective of their stage of construction are given in Table IV.

TABLE II

Number of females per territory in three different colony groups in the Poona area. (Total number of territories examined : 41)

	Hingane colony (Tree over well)	Parbati Hill colonies (Bushes over wells)	Agricultural College colony (Palm tree)	Totals of territories
Territories unoccupied by females	2	..	..	2
Territories occupied by 1 female	9	10	3	22
Territories occupied by 2 females	4	4	6	14
Territories occupied by 3 females	..	2	1	3
Mean number of females per territory	1.13	1.5	1.8	1.44

TABLE III

The construction stages of nests maintained by males in territories occupied by 1, 2, or 3 females respectively. (Number of territories examined : 41. The numerals represent the number of territories of each nest composition.)

Territories of differing nest composition occupied by 1, 2, or 3 females	Hingane colony	Parbati Hill colonies	Agricultural College colony	Total of territories in each category
Unoccupied territories :				
1 Helmet stage nest only	2	..	..	2
Territories occupied by a single female :				
1 Helmet stage plus 1 complete nest	8	10	1	19
0 Helmet stage, 1 complete	..	..	1	1
2 Helmet stages plus 1 complete nest	1	..	1	2
Territories occupied by two females :				
1 Helmet stage plus 2 complete nests	3	3	3	9
2 Helmet stages plus 2 complete nests	1	1	3	5
Territories occupied by three females :				
0 Helmet stage nests, but three complete ones	..	..	1	1
1 Helmet stage nest plus three complete ones	..	2	..	2

Table IV

The number of structures maintained by males in their territories irrespective of their stages of construction. (Phases II and III of breeding)

Number of structures in territory	Number of cases
1	3
2	24
3	12
4	2

From the above discussion we may note the following points :

i. While the actual tertiary sex ratio in the three colony areas studied was only 1 male : 1.44 females, the males nevertheless normally maintained an additional structure at the helmet stage ready for any female that might accept it.

ii. The numbers of females and completed nests per territory appear to differ in the three areas studied (Table II). In particular the colony high in a palm tree had a greater mean number of females per territory than those established over wells. A contingency test shows χ^2 to be 9.23 for which p lies between ·1 and ·2. Although the differences are not thereby shown to be significant this could be due to the numbers available for the test being small. It is thus possible that a real difference does exist. Such a difference could be due to the greater density of potential nest sites on the palm leaves and birds packing more nests into their restricted territories. Further figures from contrasting colony sites are required to test this idea.

iii. Polygamy in the Baya is based clearly upon the greater availability of potent females compared with potent males in any one season. The disproportionate sex ratio in the breeding colonies is probably due to the failure of the males to breed in their first year. However, since the sex ratio of fledgelings has been shown to be slightly in favour of males, the question remains open.

II. Territory

1. General

The male Baya establishes his ownership of a particular site by loud song and aggressive behaviour (see p. 15) to all approaching birds. He also gives the nest advertisement display there (p. 22). Careful observations mostly in the Hingane colony in 1958 revealed the following facts :

i. At least two males may build upon established nest sites up to the helmet stage ; thus neighbours build upon each other's nests during the earliest stage of construction. This was observed only at the onset of breeding when the first nests were being started. At this time the territorial aggressiveness of the male is least marked and territories barely established.

ii. Defence of the site begins soon after the first stitches have been made in any selected place. The founder soon becomes intolerant of other males visiting his nest and building upon it and any attempt to do so may lead to a fight. Thereafter, males approaching nests other than their own do so in sleeked postures (strong tendency to flee) and usually make attempts to steal material for their own nests. Two nest sites may be established at once : usually they are close together, and the male may thus construct two wads at the same time. Usually one nest develops faster than the other and becomes the centre of the territory.

iii. Two established nests of a male may be separated occasionally by a great distance. Two cases were observed at Hingane in which the two nests of a male were situated on opposite sides of the well. The territories of these birds were thus in two parts. In both cases the double territories were maintained for a few days until one of the nests was abandoned and its site no longer visited or defended.

iv. Experiments (see below) show that the spatial extent of a Baya territory is compressible down to that of the nest (or the nests) itself. Thus when nests were brought very close together, the males would lunge at one another from them and show much threat, but in no case was a nest abandoned and rarely did ferocious fighting result. It is thus the nest itself rather than a volume of space of certain size around it which is significant. However, supplanting attacks are often made at neighbouring males during establishment of the territories and threat occurs at distances of between three and six feet approximately from the nest site. The distance from the nest at which a male refuses to retreat in the face of threat or attack is easily observed and marks the inner limits of a boundary zone. The territories are so packed that there is rarely any ‘ no man’s land ’ between them.

v. A further factor influences the size of territories. This is the frequency of suitable sites in a given area. Thus over wells, where the vegetation is sparse and the numbers of suitable twigs few and scattered, the defended areas may be large, up to several square feet. On the hanging leaves of tall palms, however, every pinna of which offers a suitable site, nests are frequently placed very close together and the territories are much smaller as a result. It is thus partly the distribution of suitable sites that determines the number and the size of the territories within a given area. The males establish territories including as much space around their nests as their neighbours allow them.

2. Experimental compression of territories

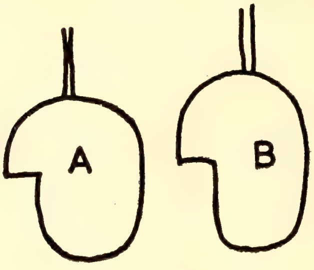
A number of simple experiments were made to determine the extent of the defended area and changes in behaviour of the individuals concerned under modified conditions. Nests of neighbouring males were moved closer to one another and the behaviour before and after the move was recorded.

Test I. Two neighbouring nests, A and B, originally two feet apart, were wired together with approximately one inch between them. The entrance remained in the same relative position throughout (see figure). The nests were completed egg chambers but only A was certainly accepted by a female.

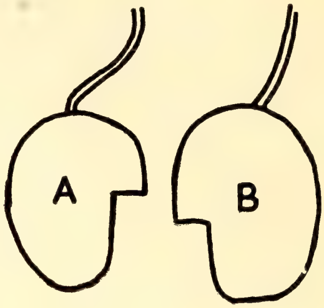
For 15 minutes before the test the nests were watched closely and the two males were present on their respective nests several times. No aggressive encounter of any sort was observed between them. As soon as the change was made the two males returned to their nests and at once assumed mild threat postures (i.e. Tail depressed Threat). Bird B fixated bird A intensely but kept the body of his nest between himself and his opponent. Bird A maintained his threat posture and sat on a twig above his nest with his back to B much of the time. Whenever A hopped down to his nest, B hopped off his on to a twig, a little further from A than before, and whenever B hopped to his nest, A retreated to a twig in the same manner. Once when male A flew to his own nest, B supplanted him and twice, when female A flew to nest A, both males attempted to enter the nest (copulation attempt) after her but, after a brief supplant from male A, B retired to his own nest. Most of the time the males sat near their nests taking little note of each other. When male B was absent for a time male A made shaping movements in the beginnings of the tube on nest B and then, sitting on nest A, leaned out and pulled a small strand off nest B.

At the end of the test the nests were restored to their original positions.

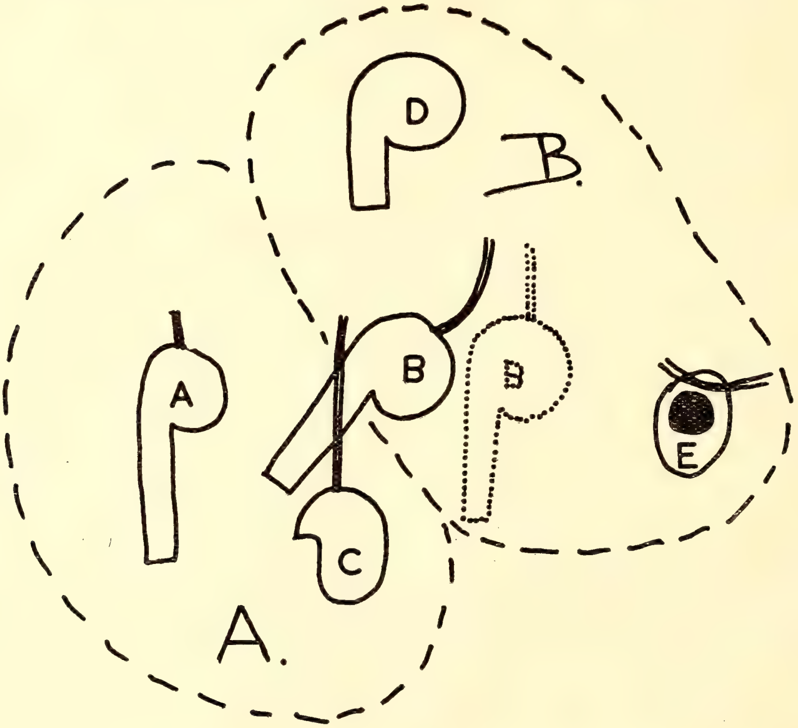
Test II. The same two nests were wired together at the same distance but this time with their entrances close together. Male A pulled out the wire so that the nests swung apart and the experiment had to be set up again and left over night. Next morning A hopped about on both nests but mainly on A. His female entered nest A and the male displayed there. On her emergence she entered nest B and male A thereupon sang upon it and tried to enter it in a copulation attempt. The female titivated on both nests. Later, in the absence of male A another male, very sleeked, visited both nests twice. It was perhaps B but he was not certainly present at the nests at all.



TEST I



TEST II



TEST III

Note on Tests I and II The tests show that the territories were compressible without fighting occurring between the owners. There was, however, a very clear increase in threat, and the owners showed a strong tendency to avoid one another. Neither bird would allow the other on its nest which thus marked the limit of the compressibility of the territories. Male A appeared dominant to B, this being enhanced perhaps by his possession of a female which visited both nests in the absence of male B. In Test II, after the entrances had been apposed, it appeared that male A had taken over both nests and that, if B came at all, it was in the sleeked posture of a trespassing bird. No bird other than A showed territorial ownership at the two nests during Test II (see also Test IV).

TEST III. Two neighbouring territories, again called A and B, were chosen. Male A owned nests A (completed with tube and female) and C (uncompleted helmet stage nest with no female). Male B owned nests B (completed with tube and female), D (old completed, no female) and E (abandoned helmet stage nest). In the test the nest B was slightly tilted and wired so that its tube entrance opened into the defended area of A only two inches from the tube of nest A (figure).

Before the change no interaction (beyond one case in which male B attempted to follow female A into her nest and was supplanted by male A) between the birds of the territories was observed. Immediately after the change the following events were recorded :

1. Female B returned and hopped on to a twig, which had been previously her last perch before flying up the tube of her nest. She flicked wings and tail in obvious ' anxiety ' (intention movement of flight) and repeatedly flew between the twig and the top of her nest B. She never approached the tube entrance of the nest. She then flew to old nest D and the male B followed her there and gave a full advertisement display (p. 22) upon it. Previously no female had visited this nest. Male B then approached the displaced entrance but did not enter.
2. Female B apparently located her displaced nest entrance and made two attempts to fly up into it. On both occasions male A chased her off.
3. Male A wing quivered and gave pseudo-female solicitation to female B as she hopped about anxiously on her nest (B).
4. Female A, on leaving nest A, entered nest B. Later she entered B in addition to her own nest several times. Male A greeted her with wing quivering and pseudo-female solicitation at both nest entrances.
5. Female B visited nests D and E : at D male B advertised but at E he supplanted her. Later he advertised here as well as giving further supplants.

6. Female B made further attempts to enter nest B but once more was supplanted by male A.
7. When male A was absent, female A was supplanted by male B on trying to enter nest A. Later when she flew to her nest, male B wing quivered and gave pseudo-female solicitation to her while perched on nest C. The female took no notice but flew into nest A.
8. When no other bird was present female B once arrived on the top of her nest and then flew down and entered nest A.

After forty-five minutes the nest B was restored to its original position. On returning, female B alighted on nest C and supplanted female A near it. Male B then alighted on nest B and sang ; whereupon female B at once flew to nest B and entered it. From then on the original behaviour of females A and B was restored, each going to its appropriate nest. Once, however, female B supplanted female A as the latter was going to nest A.

Note on Test III. The displacement of the nest entrance at the end of a long tube into the centre of a neighbouring territory effectively prevented both the male and the female owner from entering. The male was singularly undisturbed by the change and no aggressive encounters between him and his neighbour were recorded. The female, however, was much disturbed and made several attempts to enter her nest by passing through the neighbour's territory. On each occasion she was driven out. During her anxious hopping about the neighbouring male greeted her once with wing quivering and solicitation as if she were his own female. In addition, she visited two abandoned nests of her own mate at which he resumed typical ' Advertisement ' and supplanting behaviour. In the absence of male A from his territory, male B extended his into it and drove off the former's female. Female B could then enter her own nest ; instead she actually entered that of the neighbouring female. On restoring the nest to its original position, female B resumed her original behaviour. The test showed that movement of the nest entrance disturbed the female only and that her anxious wanderings produced the following responses from the otherwise unconcerned males :

i. The neighbouring male showed defensive supplanting and courtship approaches identical with those with which he greeted his own female.
ii. Her own male resumed advertisement display and courtship at his more or less abandoned nest sites as soon as she began visiting them.
iii. When the neighbouring male was absent the original owner expanded his territory to cover the displacement of his nest tube and in doing so supplanted the neighbouring female.

The return of the neighbouring male restored the defended area to its original size. Thus so long as neighbouring males are present, displacement of the nest entrances does not bring about a change in the spatial relations of their territories.

Test IV. The following day a further experiment was carried out using the same nest group as in Test III. Nests A and B were wired together so that their entrance tubes hung a foot apart instead of three feet. Nest C was then moved to a position to the right of nest B thus bringing it into B's territory. The following occurred :

1. The two females both arrived on nest A on returning, and a fight occurred. B took nest C for her own nest and hopped on it several times until she found the B nest entrance tube and went in. Female A showed repeated threat postures at female B.
2. Female A arrived on nest B. At once female B attacked and a short fight followed before female A retired to her own nest.
3. Female B spent much time on nest C titivating it as if it were her own nest.
4. Male B titivated on nest C and hopped about on it. Male A took no notice.
5. Strong ' Tail depressed Threat ' postures were given by male A when male B was in nest B. Otherwise only mild threat posturing as normally seen between neighbours was observed. When male B titivated on nest C male A fixated him but no encounter developed.

Note on Test IV. The change in the positions of the nests and the distance between them led to confused female behaviour when they returned to their territories. Fights occurred whenever they alighted on each other's nests apparently in mistake. Female B took interest in nest C formerly of A's territory but now placed in nest B's position relative to the other nests. This nest was adopted by male B and male A did not defend it. There was an increase in the frequency and strength of threat posturing between the neighbouring males.

Tests V and VI. In two other tests nests of two further territories were brought close together. The original distances between the nests were three feet ; after changing the nests they were at three inches and nine inches in the two tests respectively.

Results :

1. Males showed an increase in the frequency and strength of threatening in Test V.
2. In Test VI (during which the two males were never seen present at the same time) the female whose nest had been moved the most showed the greatest anxiety (e.g. wing flicking) calling and hopping about agitatedly.

3. The nests were not returned to their original positions after the tests. Aggression and anxious behaviour both disappeared after a few hours and thereafter normal territorial behaviour was recorded.

TEST VII. The young were removed from two nests and the behaviour of the returning females watched. Both became excessively anxious and visited all neighbouring nests. As these were empty no interactions with other birds occurred.

Summary of Tests :

The results of all these tests may be summarised as follows :

(1) If occupied nests are moved closer to one another during brooding there is an increase in threatening behaviour between the neighbouring males.

(2) If the entrance tube of an occupied nest is tilted so that it opens within a neighbouring territory, the owner female is prevented from entering it by the neighbouring male. The male owner does not attempt to defend the entrance tube of his nest when the neighbouring male hops on it or the female enters it.

(3) If unoccupied nests are moved into a neighbouring territory or placed near another male's nest they change owners (Tests II and IV).

(4) Displacement of nests confuses the females who follow regular routes and use certain landmarks in locating them. They become very anxious showing wing flicking, calling, and visiting several neighbouring nests. This results in fights between the various female nest owners. Neighbouring males respond to the wanderings of females with supplanting attacks or occasionally with sexual 'greetings' both of which the females avoid.

(5) When unoccupied nests are kept with reduced distances between them, the aggressive responses gradually fade until finally the interactions between the two pairs do not differ from those of birds in territories in which the nests have not been moved. The birds thus adapt themselves quickly to a much reduced territory size.

(6) The defended area can be reduced to little more than the nest itself. The arrival of strange or neighbouring birds on a nest is never tolerated.

III. AGONISTIC AND TERRITORIAL BEHAVIOUR

1. Behaviour in flocks

Baya weavers are 'Distance' species (Hediger 1950) and maintain an 'individual distance' when moving together in groups. Each individual prevents another coming near it by aggressive or fleeing behaviour depending upon the relative dominance of the two birds in the encounter. In caged groups stable ' peck right ' hierarchies are established but in wild flocks it is unlikely that the group composition is sufficiently constant for individuals to learn to recognise one another enough for this to occur. The dominance shown by one bird to another in a wild flock is thus not likely to be learnt in relation to the opponent. It is rather the expression of the innate relative dominance of the two birds. The actual tolerance distance around an individual within which another individual is never permitted is small, being about two inches, depending on the mood of the bird. It thus resembles distances estimated for other Weaver species in aviaries in Cambridge and in Senegal (Crook 1958).

The typical threat posture, composed of components that are intention movements of attack and escape, is the ' Head forward Threat ' (Hinde 1953). Components indicating the tendency to attack are the crouched posture, the head held low, forward, and often rather pulled back into the shoulders, and sometimes a spread tail. Components showing a tendency to flee are the sleeking of the body plumage and a turning away from the opponent. The most frequent form of attack is the ' Supplant ' (Hinde 1952) in which a bird fixates another, often in the Head forward Threat posture, and then flies directly at it and takes its perch as it flees. If it does not flee, a short fight occurs. ' Supplants ' are frequent at food sources, at another bird when it has some nesting material, and in any competitive situation. Another aggressive movement, the ' Lunge ', is a brisk reaching-out at the opponent as if to peck it, accompanied by an aggressive chatter. It occurs often during ' individual distance ' encounters on perches, the birds then separating out and so increasing the distance between them. The ' lunge ' may end in a peck in which the opponent's plumage is seized in the beak. This often starts a fight.

2. Agonistic behaviour in territorial defence and courtship

Once a male has established himself in a territory, his aggressive postures are used both in territorial defence and in the various encounters occurring outside the colony in flocks. The Head forward Threat and the Lunge are now frequently associated with the loud wheezy song which functions here in claiming ownership of the site and in warning other males to keep away. At wads, initial rings, and early helmet stage nests, the males threaten their neighbours primarily by supplanting those that come close (about three feet from the nest in a palm tree colony). Birds that hop near the borders of a defended area are treated to a loud song and much ocular fixation, the owner advancing towards them and eventually supplanting or relaxing depending on whether the other bird retreats or not.

When the helmet stage of the nest is reached and most neighbours know each other well, a further threat posture the ' Tail depressed

Threat' appears. The components are: (i) Body plumage slightly fluffed, (ii) head lowered, retracted into shoulders, (iii) tail very depressed and spread, and (iv) song or aggressive chatter. Interpretations of the motivation of this posture have been published previously (Crook, in press *a* and *b*). It arises in situations in which a sexually motivated bird is also tending to respond to an intruder with both attack and escape. It is most common in weaver species with small territories such as the *Quelea*. In the Baya the posture appears most commonly in courtship when the female has partially accepted the male's nest and the dominance-subordination relationship between the sexes is changing in favour of the female. The male then begins to show a tendency to flee from her as well as to attack her; this is expressed by the fluffing of the body feathers (i.e. thwarted escape found in many submissive postures also). The lowered head drawn back into the shoulders, the spread tail, and the calls are aggressive while the depression of the tail, especially frequent in aggression against the female (see Table V), appears to express attack and sex together.

The exact contexts of 228 sequences of aggressive behaviour are shown in Table V. A glance at the totals of sequences for each context shows that the highest number (32.5% of the total) occurred when the male attacked or threatened the female following nest invitation displays and the female's initial approaches to the nest. In these sequences the male mostly lunged at the female (95% of the cases in the context) and in the remaining cases he supplanted her. The greater number of lunges over supplants is due to the close proximity of the birds at the nest during the invitation sequences. In addition, the male is at the time showing alternating tendencies to approach the female, either in a mounting attempt or in an attack and to flee from her. Due to this conflict situation the male's lunge rarely develops into a full attack and few supplants are seen for the same reason. In courtship, following acceptance of the nest, the behaviour is less confined to the nest and supplants leading to sexual chases are more common than lunges. Large numbers of aggressive sequences were also seen when males passed near the territory (mostly supplants, 79% of cases in context, or a few Tail depressed Threats always given to well-established neighbours, 21%) and with females, during courtship sequences, when many Tail depressed Threats (37% of sequences in context) were seen in addition to the many supplants (58%). The numbers of sequences in other contexts are also given in Table V.

Of the different types of aggressive response 91% of the lunges occurred as the female approached an advertising male. The majority of supplanting attacks was given against approaching males (33%) or neighbouring males in display (26%) with a further high number occurring during the courtship sequences (19%). Tail depressed Threat occur-

TABLE V

The occurrence of the three main types of aggressive behaviour of male *Ploceus philippinus* in differing contexts in territorial defence and pair formation.

Contexts	Aggressive Responses			
	Lunge (i.e. Head forward Threat with attempted peck)	Supplanting attack	Tail depressed Threat	Total of sequences per context
Strange male at the nest	..	9	..	9
Neighbouring male in full display in nest advertisement ; no female present	2	25	2	29
Neighbouring male in full advertisement display ; female near attacker's nest	..	8	..	8
Another male passes close by nest	2	43	9 (to neighbouring birds)	54
Attack on female during nest invitation (i.e. following her arrival after the advertisement display)	67	7	..	74
Attack on female during courtship	2	25	16	43
Strange male attacked while at a *neighbour's* nest	..	8	..	8
Aggressor attempts to rob material being carried by another male	..	3	..	3
Totals of sequences	73	128	27	228

red most commonly in courtship sequences (59% of cases observed). Eight supplants were seen against strange males visiting nests belonging to the neighbours of the defender. In this case the latter sallied forth from his territory to defend a neighbour's nest in his absence. It seems that the sleeked appearance of male strangers encourages attack even from a distance beyond the territory. In this way males sometimes save the nests of their neighbours from robbers. Owners of nests at which a female was visiting sometimes attacked neighbouring males who were advertising near by (8 cases). However, since the owners in such contexts are primarily occupied with the female the number of aggressive responses to near-by males is much less than when a group of males displays together in the absence of a female (29 cases).

3. Discussion of agonistic postures in pair formation

Supplants are shown by birds motivated by an unopposed attack tendency. Lunges, when they develop into a pecking attack, may be interpreted in the same way but in most cases the lunge does not reach the target and the bird often withdraws. Lunging thus is usually part of a posture or sequence in which attack and escape response tendencies are in conflict. We have already seen that they may be given to both males and to females. In the Tail depressed Threat attack, escape, and sex tendencies are all activated. The majority of these postures occur in response to the female in courtship sequences. Nevertheless they also play an important role in territorial defence against neighbouring males once the nests have been well established. This is presumably because the posture has acquired value as a social signal proclaiming ownership of a nest and territory during the course of its evolution and ritualisation (further discussion in Crook, in press *b*).

4. The occurrence of song

The loud wheezy song is heard in the following contexts :

(1) Given by several males in concert while resting in a group. Often it occurs during bouts of preening or sitting drowsily and well before breeding commences. Thus loud singing may be heard in groups in day roosts in March and April. The song is not orientated at any other individual nor does the song posture reveal any component associated with attack tendency.

(2) Males may sit in their territories and sing without orientation to other individuals and without attack tendency present.

(3) Song may be given at males approaching or near the territory. In these cases the posture includes threat components (e.g. rump fluffing, tail spreading) and the bird faces the opponent.

(4) After giving a supplant the male may return to his territory and sing.

(5) The males repeatedly sing to females after their arrival at the

> nest. Such songs are given during the performance of ‘ wings rigid ’ posturing (p. 22) and in the post-courtship phase after abortive threats. They are often given on the exterior of the nest, the female being within.

In (1) and (2) there is no aggressive motivation apparent and no reason to suppose its presence. Song increases as the breeding season approaches though it appears to be present to some extent throughout the dry season. Thus caged hand-reared juveniles sing when a few weeks old though the song is not yet fully formed. Song is evidently associated with sexual motivation and its repetition in choruses, in which social facilitation plays a notable role, may possibly bring about a synchronisation of the timing of maturation so that all birds are physiologically ripe when environmental stimuli elicit breeding. In (3) and (4), however, song is occurring in aggressive contexts and functions in announcing the ownership of a site and thus as a warning to neighbouring males. In (5) too the context is aggressive though sexual motivation is usually apparent at the same time. It is unlikely, therefore, that the song plays much part in attracting the female and, further, the vocalisation accompanying the advertisement display is totally different (p. 22). Song is most marked, except in (1) and (3), where there is a conflict between two or more tendencies and where the tendency to attack is especially strong.

IV. Nest Invitation, Courtship, and Harem Formation

1. The pair formation process

In common with many other Ploceine species the pairing process of the Baya falls under two headings : (i) nest invitation by ‘ advertisement ’ display, and (ii) courtship. As soon as the nest reaches the ‘ ring ’ stage, the ‘ advertisement ’ displays are given upon them, although usually not at the full intensity achieved later on helmet stage nests. The display (see below) consists in a vigorous wing beating given while hanging below the nest and clearly functions in attracting the female. Courtship posturing follows the arrival of a female at a nest with which she is already familiar following frequent previous visits. The male's initial hostility to her wanes ; he begins to court her, and she shows sexual solicitation in return. Copulation eventually results. After egg laying, throughout brooding and the rearing of the young, several courtship postures are retained as part of the greeting ritual shown mutually by the birds whenever they meet at the nest. These postures may also lead to copulation even when the young of the pair are well grown. The courtship postures, in modified form, are found throughout the entire occupation of the nest by the female and her family.

Before describing the details of these behaviour patterns and sequences, the changes in the mutual behaviour of male and female in the territory at different periods in the annual life of the colony may be summarised.

A. Preliminary breeding attempts (i.e. after the first early showers of the monsoon)

i. Nest as a wad or ring.	The male's responses to the female's approach are at this stage primarily aggressive. Advertisement displays may be given as a result of social facilitation with the displaying of other males on more advanced nests near by ; they are never long sustained.
ii. Nest at helmet stage.	Prolonged and excited advertisement displays follow the arrival of a female or group of females in the colony. When the female approaches and enters a nest, the owner responds with courtship but copulation does not yet occur nor does the female solicit. The male frequently becomes very aggressive towards the female as soon as she alights on his nest, even though this may follow several minutes of ardent invitation. The nervous female flees at the slightest provocation.

During these preliminary breeding attempts activity in the colonies is only sustained for a few days. It then rapidly wanes and the place becomes once more deserted until further showers of rain are accompanied by renewed activity.

B. Definitive breeding season.

As soon as definitive breeding starts the above activities are again observed at wads, rings, and helmet stage nests. Now, however, the nests are constructed beyond the helmet stage following their acceptance by the female.

PHASE I

Nest as a completed egg chamber :	Nests of this stage have been accepted by the females and courtship occurs on and near them at maximum intensity. Whenever the females fly from the nests the males chase them for considerable distances outside the

colony and the females lead them back to their nests. At the nests the females solicit and the males copulate with them. The females also frequently refuse to copulate and attack the males instead. In such sequences the males often give the pseudo-female solicitation postures which form a marked element in courtship. As a female becomes established at a nest site advertising becomes rarer though it is maintained at the fresh nests in the territory.

PHASE II

Eggs in the nest :

Females visiting the nests for brooding are greeted by the males with much wing quivering and often pseudo-female posturing. Copulation can still occur.

PHASE III

Young in the nest :

Greeting behaviour becomes less frequent as the male remains in his territory for shorter periods. He also often assists in feeding well-grown young.

PHASE IV

Young away from colony :

Both parents feed the young after they have left the nest. No courtship or greeting postures have been seen between the sexes at this time.

2. Nest invitation and the early courtship sequences

Females are not present in the colonies at their establishment. The males busy themselves building, robbing each other's nests of material, supplanting one another and indulging in bouts of singing. The females first appear either singly or in small groups flying swiftly into the colony, hopping rapidly about the branches in very nervous sleeked postures, and occasionally flying up to a nest or two giving them apparently a brief inspection. The males with wads or rings usually react aggressively to the females' approach, threatening them and making short swift supplanting attacks. Males with helmet stage nests react strongly to the females' arrival giving intense ' Advertisement displays ', hanging below their nests, and a particular call. Between displays they hop about wing quivering intensely and repeatedly fly back to their nests for further displays. The males advertise either with the female present near the nest or when stimulated by the displaying of neighbouring birds. Thus even if only one or two females have entered the colony many of the males burst out in display immediately. Birds with wad or ring nests usually only quiver the wings or sometimes continue their building without responding to the females. The displays clearly attract the females for they rarely approach nests earlier than the helmet stage, and confine their attention especially to those upon which the males display.

The Advertisement display has two main forms, the Wings beating Display and the Wings rigid Display. Both displays are associated with much wing quivering which frequently precedes a bout of display. The Wings beating Display is given on the nest or on twigs near it. On the nest the males usually perform upside down but on twigs the body is normally upright. Wings beating Display is given during the female's approach and prior to her arrival but the Wings rigid Display is given immediately she alights on the nest. One can thus observe a transition from wing beating to the rigid posture on the arrival of the female.

The Wings beating Display has the following components :

(1) The bird hangs from the nest, usually positioned on the developing roof of the egg chamber. Frequently the line of the back is inclined at an angle of 45° to the vertical, but often the bird is completely upside down with the back horizontal.

(2) The wings are fully spread and hang down below the back. When the display is given in the 'upright' position the wings are of course extended and raised above the body.

(3) In either case the wings are beaten at a speed of about 10 beats per 1.8 seconds (Table VI) through an arc between approximately 45° and 135° to the dorso-ventral plane of the bird's body.

(4) The tail is slightly spread and either held in line with the back or slightly depressed upwards against the fabric of the nest.

(5) The birds emit a continuous call rendered *wheetu wheetu wheetu* or *che weee che weee che weee* in the field notebooks.

(6) The beak is often held down against the breast during display or the bird may peer around after other birds.

On the female's arrival the display changes to the Wings rigid Display through the successive development of the following components :

(1) The bird remains hanging on the nest in the same position.

(2) Wing beating ceases totally and the wings are held stiffly out

at the side of the body at between 45° and 90° to the dorso-ventral plane of the body.

(3) The tail remains spread.

(4) The feathers of the crown are raised.

(5) The bird leans forward slightly towards the female, often peering under the edge of the nest wall and sings loudly.

(6) As the bird leans forward with the crest raising, the wings are usually synchronously relaxed to the side of the body, a movement usually complete as the song begins.

During the initial approaches of the females the males' responses were closely observed on 154 occasions. During 50 of these the female remained near the nest but did not approach it closely, while the male merely quivered his partially extended wings. On 104 occasions the females came exceedingly close to the nests and the males gave the Wings beating Display often coupled with short flights down towards the female where they perched on twigs and gave either wing quivering or upright Wings beating Displays. In 74 cases the female alighted on the nest and the male responded with the Wings Rigid posture, a song, and often an attempt at pecking the female. A large number of these sequences were tape recorded and are shown in Schemes A, B, and C.

While visiting the colony the female is sleeked and nervous, showing a strong tendency to flee. She darts from one position to another, being frequently supplanted by the males and chased by them. Finally she alights in the nest of a displaying bird and, maintaining her very sleeked plumage, makes shaping movements in the cavity. As soon as the male threatens she flees.

3. Nest acceptance and pair bond formation

The females clearly make a choice of the nest they are to occupy for although at first they may visit several nests they soon concentrate their attention on one nest only and no longer visit others. It is difficult to gauge how far the female is affected by the male's displaying in making her choice of nests and how far it is the nest structure itself that counts. The fact that females only accept nests that have reached the helmet stage suggests that the structure itself plays the more important role though it is likely that nest structure and the male's performance taken together combine in influencing the female. However, once a female returns persistently to any given site the behaviour of the male undergoes a change and courtship rather than advertisement becomes the chief activity at the nest.

The change in behaviour occurs gradually. The original short supplanting chases whereby the male drove the female from his territory become more sustained and the male may pursue the female outside the colony. After these long chases he may at first return alone but eventually the female, after leading the pursuing male in a long detour up to several hundred yards around the colony, flies straight back into it and alights in the male's nest. The chases lose their aggressive character and become interwoven with other courtship activities, the motivation of the chase becoming, at least in part, clearly sexual. The male may now make attempts at mounting the female, attempts at which the latter at first reacts aggressively, lunging or fiercely threatening the male. The chases are interpreted as prolonged attempts at mounting. During these sequences a change in the relative dominance of the two birds occurs so that the male can no longer dislodge the female from his nest so frequently. Thus whenever the male turns aggressive the female often pecks back with such effect that he desists and sits disconsolately near by until, as she flies off in her own time, he chases her. In scheme A these later sequences are marked with an asterisk.

Table VI

Wing beating speeds in the Advertisement Displays of *Ploceus philippinus*
(Stopwatch accurate to 0.1 second)

Time taken for ten wing beats in seconds	Number of cases observed	
1.4	1	5
1.5	4	
1.6	3	7
1.7	4	
1.8	14	18
1.9	4@	
2.0	12	16
2.1	4	
2.2	2	2
2.3	0	

@ This reading is due clearly to some subjective bias for reading 1.8 or 2.0 rather than 1.9 on the stopwatch dial.

By this time the nest is nearly finished. The usual sequence of events in the territory is summarised below :

(1) The female alights in the nest entrance. The male, who may have given a few wing beating movements, usually sings

and then makes repeated attempts to enter his own nest. Some of these attempts are highly aggressive but the majority are attempts at copulation. The female refuses entry to him and when she departs he chases her.

(2) Ultimately, however, the female responds to the male's constant advances with solicitation and, although in many cases this turns again to threat as the male approaches, it ultimately ends in a successful copulation.

(3) At this time the male's sexual excitement is very evident. Apart from occasional bouts of aggressive behaviour, he is constantly wing quivering and approaching the female in short flights attempting to mount her. As the female is usually positioned in the ring entrance of the nest most of the attempted copulations occur there, but they also occur on other parts of the nest or on twigs near by. If the nest has a fully completed egg chamber and the start of a tube, then the male attempts to mount the female as she is sitting on the cross bar of the nest (the former perching position in the base of the initial ring of the nest frame) within the base of the tube. Such cases may be observed by tilting the nests so that the observer can see up the tube. Many of these attempts fail as the female repeatedly turns on the male and drives him off.

(4) Under intense sexual frustration (i.e. following repeated rejection of his advances) the male gives pseudo-female solicitation, thereby soliciting the female in exactly the same postures as those whereby she solicits him.

In these copulation sequences the behaviour is extremely variable. The male's wing quivering advances may be met with an immediate crouching of the female and copulation may then follow immediately. Usually, however, the female resists the male's approaches with some degree of aggression alternating this with spells of wing quivering in concert with him. When the female solicits copulation normally follows at once, but when the male solicits the female usually responds only with wing quivering. She may also solicit, however, in which case again copulation is the normal consequence. The process is highly elaborate and the male by constant wooing provides the stimuli that elicit the female's sexual responses thereby suppressing her tendency to attack. The female's sexual behaviour (soliciting, etc.) elicits the male's responses and results in copulation.

Solicitation by the female has the following components :

(1) The body is deeply crouched and the breast especially lowered,

the feathering of the breast and body being often slightly fluffed.

(2) The wings are drooped slightly but only a little spread. The initial wing quivering that normally precedes solicitation gives way to extremely high speed tremoring most noticeable at the wing tips.

(3) The tail is slightly raised and tremored in the vertical plane at high speed.

(4) The head may be slightly tilted backwards and the beak thus points upwards.

(5) Crown and nape slightly fluffed.

The components of the male's pseudo-female solicitation are closely similar to the above though the body is rarely so deeply crouched and the head is less prominently tilted. In the male's display wing quivering with fluffed body plumage changes to pseudo-female solicitation by an increase in the speed of the wing movements with a marked decrease in their amplitude. At the same time the tail is slightly raised and tremored at high speed. When giving this posture the male frequently gives a special cry, a high pitched *ti ti ti ti ti t t eeee* which also accompanies the act of copulatory mounting. Also when highly excited the male may clipper his mandibles together producing rapid little snipping sounds. This happens particularly when the male is flitting after the female in the territory, much fluffed and wing quivering and obviously highly motivated sexually.

When the male mounts the female prior to copulation she crouches in solicitation and her tail often keeps up the high speed tremoring. She then raises her beak and points it up vertically. The male then lowers his cloaca to make contact with that of the female who raises her rump and puts her tail to one side. The male utters the copulation call and flutters his wings throughout. After copulation the pair usually separate and the female is very prone to attack the male. Often, however, she flies rapidly out of the colony leaving the male hopping about often wing quivering. The female has been observed making washing movements with the wings after a copulation.

4. Analysis of behaviour sequences during courtship with comparisons with other colonial weaver birds

In Scheme A behaviour sequences recorded during nest invitation are drawn to reveal the variety of responses that occur. In Scheme B and C sequences of male and female behaviour respectively are shown during courtship and copulation. Nest invitation and courtship do, of course, merge into one another but their separation in the Schemes is justified because there is in fact a considerable and fairly abrupt change in the behaviour of the birds as soon as the female comes repeatedly to the nest and thereby demonstrates her acceptance of it. Nest invitation displays thereafter become less frequent and intermingled with a far greater frequency of courtship sequences. In addition, acceptance of the nest marks a major change in the male's building activity. The nest is at first rapidly constructed up to the helmet stage and then maintained without further change of form until a female has accepted it. Thereupon the male resumes construction at high speed completing the nest chamber in time for the laying of the clutch. The tube is only added during the laying and early brooding. The change in behaviour was shown clearly on 12 August 1958 when a count of Wings beating Displays during a set observation period gave 44 on helmet stage nests but only 7 on nests with recently completed egg chambers.

An individual male may have several nests at one of which courtship is in full swing while at another he may give Advertisement Displays. Thus at any one time in different territories some males are advertising, others courting, and others doing the former at one nest and the latter at another. At the Hingane colony this mixture of behaviour persisted from 6 August to 10 August 1958 approximately by which time most females had commenced laying and the majority of nests had been accepted. Throughout the whole life of the colony, however, there were some males with helmet stage nests at which they continued to advertise long after fresh females had ceased prospecting and while their other nests contained well-grown young.

A. Nest Invitation

Sequences following 141 arrivals of females in the colony (Scheme A) show that 94 (66.8%) were followed by Wings beating Displays by the males at helmet stage nests, 16 (11.3%) by threat at helmet stages, 16 (11.2%) by vigorous supplants and chase by the male, and 14 (10%), in which female approached wads or rings, by threat. The male thus reacts with aggression more particularly at wads and rings. As soon as the nest reaches the helmet stage he gives Advertisement Displays. Thus from treating the female primarily as an intruder to his territory the male begins responding to her in a manner that encourages her approach (i.e. wing quivering and Wings beating Display).

The sleeked, dodging-about behaviour of the female clearly encourages the supplanting attacks of the male ; yet it is clear from the start that females are to some extent recognised as such. Thus the tremendous excitement generated in the colony by the arrival of one or two females demonstrates that the birds are in no way confused with other males. Further the large amount of wing quivering occurring between pursuits and while the male is not actually displaying is a well-known component of sexual behaviour. The initial appearances of the female near the nest thus elicit both aggressive and sexual responses from the males. The females show a strong tendency to flee (constant crouching in take-off postures, frequent wing flicking, and extreme sleeking of the body plumage) yet in spite of this the tendency to approach the nests and to examine them (undoubtedly an aspect of the sexual tendency even though courtship wing quivering and solicitation is not at this time observed) brings them repeatedly back to the colony.

The Wings beating Display is most complex. In two other colonial weavers (*Ploceus cucullatus* and *P. castaneofuscus/nigerrimus*) in West Africa homologous Advertisement Displays have been analysed and discussed at length (Crook, 1958, in press *b*). The Baya's display resembles these closely and a full analysis of its motivation will not therefore be given here. But the following points are made by way of explanation and to show the differences in the nest invitation of these three very similar species :

1. The Wings beating Display is a complex posture in which components derived in evolution from sexual chasing (wings beating) and song bowing (tail spreading and depression, beak against breast) threat postures are combined into a partially ' ritualised ' static display given on or near the nest.

2. The component composition of display shows that the male is responding with attack, sex, and escape all at the same time. So long as the stimulus situation provided by the movements of the female remains relatively constant, the conflicting tendencies remain in the same effective ratio to one another. They then appear in the typical intensity, frequency, and form of display.

3. As soon as the female actually alights on the nest the male *P. philippinus* gives the Wings Rigid posture. In *P. cucullatus* the same thing occurs but it is followed immediately by ' dashing to and fro ' within the territory during which he makes frequent visits to the nest where he bows to the female, sings to her, and may lunge at her. This has been interpreted as an initial freezing of the display with the tendencies to attack and to escape from the female effectively equal, followed by alternating movements of attacks and escapes or threats at the female at the nest. In *P. castaneofuscus/nigerrimus* the male usually wing quivers or droops his wings before ' dashing to and fro '. This

is interpreted as a strong sexual response in conflict with escape, there being comparatively little attack motivation apparent. Contrasted with these, the Baya's display changes firstly to the Wings Rigid posture and then passes immediately into a threatening song bow towards the female. Of the components of the display the cessation of beating and the rigidity of the wings represents the initial 'freezing' of wings beating with the attack and escape tendencies in balance and cancelling each other's manifestation ; the spread tail, occurring otherwise in threat postures, indicates the presence of the tendency to attack ; the raised crest, occurring otherwise in alarm, indicates the tendency to flee ; the fixation of the female and the leaning forward are preparatory movements of lunging and, together with the spread tail and the song, reveal the tendency to attack ; the relaxation of the wings (component 6 on p. 23) indicates the absence of intention movements of flight.

4. All this indicates that the reaction of the Baya to the arrival of the female is primarily aggressive but that the tendency to attack is *at first* partially inhibited by the opposing tendency to flee. This interpretation (for further discussion of the analysis of components in these displays see Crook, in press *b*) is supported strongly by the subsequent events in the behaviour sequences shown in Scheme A. Thus following 74 Wings Rigid postures the male actually pecked into the nest at the female 57 times and in all but 7 cases (3 in which the male relaxed on the departure of the female and 4 in which the female threatened him) he finally chased her from the nest as she fled. Only later after much chasing (an activity that is less prominent in both the West African species) do sexual responses appear at all clearly (Scheme B).

From this account we see that the differences between the displays of the Baya and those of the two West African species are due to the relatively more aggressive responses of the male to the first approaches of the female. The female Baya also is a more aggressive creature than the female of the other two species, and only after much threatening and chasing do the birds become sufficiently accustomed to one another for mutual sexual behaviour to become possible. The aggressive nature of the female also accounts for the high incidence of pseudo-female solicitations shown by the male Baya late in pair formation. The sexual chase plays an important role in courtship. It develops out of supplanting attacks through the gradual appearance of sexual responses and late in courtship the chases are inextricably part of the pairing process, the female leading the male back to his nest where she often solicits him. The Baya differs from *P. cucullatus* and *P. castaneofuscus/nigerrimus* markedly in this respect and resembles other species [e.g. *P. benghalensis* and *P. manyar* in India and *P.* (*Xanthophilus*) *aurantius* in West Africa] in which sexual chasing plays a prominent role in courtship and nest invitation. Hinde (1953) discussing the sexual chasing of the Chaffinch (*Fringilla coelebs*) and other birds suggests that it may have a stimulating effect on the female. This is certainly so in the Baya where the female returns to the nest after a chase and solicits (Scheme C).

It has been suggested elsewhere (Crook, 1959, in press *b*) that, in the evolution of complex colonial life in certain weavers, highly motile displays in both territorial defence and nest invitation have given place to static posturings derived from the earlier movements. *P. cucullatus* and, as recent work has shown (Ali & Crook 1960), *P. megarhynchus*, in which territorial defence is conducted largely by immobile posturings and in which the sex chase is virtually absent in courtship, are the most advanced species in this respect so far observed. The Baya seems to lie between these two, together with *P. castaneofuscus/nigerrimus*, on the one hand and less colonial species on the other. The implications of these comparisons will be developed further in a later publication, by which time further species will have been studied.

B. Courtship

The behaviour sequences of the male and female during courtship are summarised in Schemes B and C respectively and the wide variety in the male's responses clearly shown (headings A-G in the Scheme). 51% (24 out of 47 cases) of the sequences in Scheme B show the male attacking or threatening (sequences passing via headings A, B and C) while the remaining sequences (23), amounting to 49%, show sexual motivation predominant. The relations between sequences under headings C and D show that initial aggressive behaviour may change easily to courtship at least for a time. Out of 23 cases in which courtship began well only 7 resulted in a successful copulation (30.5%) though a further 8 mounting attempts were made (34.7%) in which the female fled. In a further five cases (21.7%) the female reacted aggressively to the male's approaches and in one case fled in the course of courtship. In no case, where the sequence began with aggressive behaviour or included it, did a mounting attempt occur. The same situation is shown in the sequences of female behaviour, complementary to those of the males, presented in Scheme C. An attack tendency thus precludes the possibility of mating and, in a situation in which so much aggression is shown by both sexes, the frequency of sequences in which both sexes are sufficiently motivated sexually and reacting mutually without aggression is notably small.

The postures given by the birds in these sequences are mostly simple when compared with those of nest invitation. They are likewise composed of components representing the tendencies to behave sexually, to attack, and to flee. Thus in the sequences under headings A to C in Scheme B the tendencies to attack and to flee are seen in conflict. The postures may later incorporate typical sexual components such as wing quivering, and with a further increase in sexual motivation, change to postures containing sexual components alone. Under the headings D to G sequences occur in which the sexual tendency is in conflict with the tendency to flee, though here again aggressive behaviour is recurrent. The significance of most of the postures shown has been discussed elsewhere (Crook, in press *b*) so that only a summary of their interpretations need be given here :

1. Wing quivering.	Given by both sexes.
Motivation.	It is normally associated with and precedes sexual behaviour in many passerine birds (Hinde 1952, 1955-56, Marler 1956, Andrew 1957, Crook, in press *a* and *b*). Some escape motivation is also present.
Derivation.	It appears to be derived from the wing quivering of juvenile birds (Marler loc. cit.).
Function.	It is often associated with submissive 'fluffed' postures and it appears to reduce the likelihood of attack from birds approaching or approached (e.g. as in courtship and in food solicitation by juveniles to adults). It allows partners to approach one another closely prior to mounting.
2. Solicitation.	Given by the female.
Motivation.	Largely sexual though the crouching component, an intention movement of flight, suggests the tendency to escape (Marler, loc. cit.)
Derivation.	Movements of copulation and preparatory movements of flight.
Function.	Invitation to the male to copulate.
3. Pseudo-female solicitation.	Given by the male during copulation sequences and in the post-courtship period. It begins with the first copulation attempts following the acceptance of the nest by the female and thus coincides with the shift in relative dominance in her favour.
Motivation.	The sexual tendency is in conflict with a strong tendency to escape. Thus it is not found early

in courtship when the male is dominant and highly aggressive. It follows threat by the female and when the male leads the female to the nest (Scheme B, headings E and G).

Derivation. The posture consists of preparatory movements of copulation and flight and evidently shares common causal factors with female solicitation (Hinde 1955-56, p. 15).

Function. Probably the same as wing quivering. It appears also to elicit solicitation by the female. The posture has been observed in many weavers but rarely so frequently as in the Baya. The high level of aggression shown by the female which produces frequent thwarting of the male's mounting attempts is responsible.

V. The Mutual Behaviour of male and female following Pair Formation

Once the pair bond is established and courtship over, the females and males occupy themselves respectively with brooding and the courtship of further prospecting females. In addition the male is zealous in strengthening his nests, in lengthening the tubes, and in defending the territory against the depredations of robbers. The male remains most of his time in the territory, and thus established females frequently encounter him on their journey to and from their nests.

When the two birds meet, a number of alternative sequences may be observed. These are set out in Table VII where the female's behaviour on entering the nest is matched against the male's response. A glance at the totals reveals that 36.6% (i.e. 37 of 101 cases) of females arrived and flew to their nests without showing any particular posturing, 34.6% solicited their mates, 14.9% wing quivered before entering, and 9.9% solicited or wing quivered (35, 15, and 10 cases respectively) even though their mates were at the time not present in the territory. A remaining 4% solicited neighbouring males in the absence of their own. Correspondingly, of the males' responses 33.8% were pseudo-female solicitations (30 times out of 91 cases)[1], 20.1% wing quivering (19 times), and 10.9% aggression (10 cases), i.e. flying to the female at the nest and singing loudly sometimes with lunge, or supplanting. 63.3% of the males' pseudo-female solicitations were given to those females that flew directly to their nests without posturing, merely perching a moment and wing flicking (intention movement of flight) before darting up the tube (19 of 30 cases in context), and 33.3% to females that were themselves soliciting (10 cases). Females that wing quivered were solicited by the male rarely and were usually met with wing quivering. Occasionally other neighbouring males also joined in the wing quivering though without approaching near enough to invite an attack from the owner (4 cases). The frequency with which wing quivering was met by the same behaviour in response, and soliciting likewise with soliciting suggests strongly that the male, if he responds, tends to show a similar behaviour pattern to that of the female. However, the male often showed no response at all (26.2% of total male responses) and especially to soliciting females (45.7% of responses in context) ; yet only in 5 out of 37 cases (i.e. 13.5%) did the male fail to react to a female flying directly to the nest without posturing. Here it is noteworthy that of all the male's aggressive responses 60%, including all four observed supplants, were made against females that showed neither wing quivering nor solicitation on entering the territory.

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[1] On one occasion a male was observed giving pseudo-female solicitation to a male flying past, apparently a case of mistaken identity.

It is thus clear that, in addition to aggressive responses, courtship postures and solicitation persisted well after the period of their greatest significance during pair formation. The male solicited established females both when they solicited him and when they entered the territory in a sleeked manner. A number of such encounters led to mounting attempts and even to a few apparently fully competent copulations. Some of these took place at a time when the females concerned were actively engaged in feeding young. Both sexes are thus fully potent sexually for a long time after the initial pair formation. Often the male responds to his established female as if she were a prospecting newcomer and especially so if she enters the territory without greeting him (Table VII). Her sleeked posture and wing flicking then resembles the nervous behaviour of a prospecting bird. Sometimes an established female returning in this way is met with advertisement display on the latest helmet stage nest thus suggesting that the male is responding primarily to her posture and that her identity as an individual bird is indistinctly known by him. In a few cases the established female actually responds at once to the male's invitation and visits the nest, pokes about in it, is threatened by the male and so on, exactly in the manner of a freshly arrived bird, and often with food in her beak for the young all the time. Thus not only is the male liable to attack his female and invite her to a fresh nest but the female may also respond with appropriate behaviour, but in relation to her functional role at the time, certainly out of context. All this again is set against the background of repeated threats by the male. We have seen that females entering the territory without

TABLE VII

Tabular representation of behaviour sequences of females and males in territories during brooding and care of young in the nests. (The sequences follow the arrival of the female in the territory. The numbers of male responses recorded are placed against the behaviour of the female on her arrival.)

Female		Male					
Behaviour of female on arrival in colony	No of sequences observed	Male supplants female	Male gives no response	Male flies about nest, wing quivering	Male flies to or near nest; sings at female	Male gives pseudo female solicitation	Strange male wing quivers with ♀.
Female flies to nest without posturing	37	4	5	7	2	19	..
Female approaches nest, wing quivers to her mate	15	..	3	6	1	1	4
Female approaches nest soliciting her mate, often carrying food for her young at same time	35	..	16	6	3	10	..
Female approaches nest and solicits a male other than her own near her nest; own mate absent at time	4	..	..	..	..	..	4
Female in territory in absence of mate nevertheless shows wing quivering or solicitation	10 (7 are solicitations)	..	..	..	..	..	..
TOTALS	101	4	24	19	6	30	8

posturing in some way to the male are most liable to be molested, either aggressively or sexually. The wing quivering, however, functions as in courtship and reduces the likelihood of a (sexual) attack. Thus the female may usually pass quickly to the nest without the hindrance of the male's provocative solicitations. The male's wing quivering in return reveals the absence of aggression in his welcome. Thus the mutual performance of this posture is of great utility, informing the female that the male will not attack her and the male that she is neither an intruder nor a prospecting female. The strength of the female's tendency to wing quiver or solicit on arrival is indicated by the frequency with which she performs these patterns even when the male is absent from the territory. In such cases neighbouring males may approach her in attempts at a stolen copulation.

The similarity between these postures and those of late courtship indicates that the same complex of conflicting tendencies is responsible and that the relative dominance of the pair remains unchanged. The persistence of the conflict is due to the continuing sexual potency of the male after his initial courtship and his maintenance of a helmet stage nest in readiness for a fresh mate throughout the whole breeding season. It is thus a feature of the polygamous capacity of the male. It is noteworthy here that the monogamous *Quelea quelea* does not show such intensely sexual greeting behaviour after pair formation, the normal procedure being limited to extensive mutual wing quivering. In other polygamous species [e.g. *P. cucullatus*, *P. (Xanthophilus) aurantius*, and *P. megarhynchus*] solicitation postures are similarly found in both male and female postures in mutual greeting after pair formation. This suggests that where solicitation and pseudo-solicitation are common in courtship they appear also in the greeting behaviour. Thus the relative strengths of the conflicting tendencies (attack, fear, sex) responsible for the postures remain approximately the same both during and after actual pair formation, so long as the male is sexually active in courtship and the pair bond is maintained.

VI. The Behaviour of Juvenile Birds

1. On leaving the nest

Young Bayas are capable of full flight for some twenty to thirty yards on leaving their nest on approximately the fifteenth day (see Ambedkar, in preparation). Frequently during the examination of a nest the young will fly out and flutter off in different directions into the undergrowth. Sometimes, when disturbed, young birds fall into wells and drown. This seems due to a premature departure and does not appear to be a natural occurrence. In spite of attentive watching the natural departure of the young was not observed and very little is known of the role played by the parents at this time. However, one young was seen immediately after its flight from the nest. On the return of the female she fluttered over the young bird and then flew off calling into a near-by stand of sugarcane. The young bird followed it there landing within a few feet of it. The two birds were then lost to view in the dense foliage.

On leaving the colony the young birds scatter and go into dense vegetation. The family does not clump together closely at all and only single juveniles of this age have been seen. One young bird was seen near the Hingane colony shortly after its first flight from the nest and both parents were seen feeding it. It begged frequently with wing quivering and gave a shrill 'location' call. At greater distances from the colony the young have also been seen sitting still for long periods (up to twenty minutes at least in some cases) and the parents then come and feed them at intervals. The young of one family can generally be located in the same general area although the young are not perched together. One family party was found in dense bushes with a distance of ten to twenty yards separating the three young birds. As the female flies in to feed the young she gives a special *tchrrrrr* which the young birds answer by the 'location' call. As the young become older they begin to flutter more frequently after the parents when they have brought food. They thus begin to show a marked 'following reaction'. One such juvenile was seen pursuing a male as it flew into a tree. The male fed it and flew off about the tree collecting insects. Every few minutes the young would turn toward the parent and flutter towards it landing as if in a supplant attack, exactly on its perch or just beside it. The adult would then usually feed it. In this way the family maintains a loose contact that becomes more effective as the young begin to fly well.

It seems that the young enter flocks when their parents gradually cease responding to their calls. They follow the parents increasingly and gradually mix with other groups. This happens sometime after the 30th day of life. Young birds were seen among adults in flocks, often wing quivering at neighbours, and also among certain other migratory finches (e.g. Blackheaded Bunting, *Emberiza melanocephala*, and Rosefinch, *Carpodacus erythrinus*) common in the Poona area in autumn. When the flock flew off, however, the juveniles often stayed behind not yet showing full social integration with it. Later several juveniles were found together in a group feeding on cereal heads. It is not therefore altogether clear how far the young first form flocks consisting of their own age group alone and how far they integrate directly with adults. Both evidently do occur.

The behaviour of the juveniles on leaving the nest may then be characterised in three stages :

(1) Nest departure and flight from the colony during which the family becomes well scattered.

(2) Sitting still for long periods with little attempt to follow parents.

(3) The following of parents soon develops and leads eventually to the formation of family groups and to joining flocks.

This sequence differs greatly from that followed by juvenile *Quelea* on leaving their nests in Africa. *Quelea* nests are situated in dense thorn bushes and when the young leave them they scramble about the twigs for several days without attempting a single flight. The dense thorns are a perfect protection and so long as the young birds remain among them they cannot be taken by the various predators that wait beyond it (Morel & Bourlière 1956). While moving about, these youngsters show typical ' contact ' behaviour cuddling together and even preening each other (Crook, in press *a*). Both in the *Quelea* and in the Baya the juveniles eventually join flocks in which 'individual distance ' is maintained, but the behaviour prior to this differs markedly in the two species. In each case the behaviour seems to provide maximum possible security for the young. Thus for the *Quelea* the thorns are an effective protection and the young keep together. In the Baya scattering and sitting still, in an environment which is itself in no way protective, seems to be safer than any form of social grouping while the birds are incapable of sustained flight.

2. In the first year

In the first monsoon young male Bayas are busy building nests in sites quite separate from those of the adult birds. Nests of juveniles occur in small groups or in isolation but never in the large clusters typical of adult colonies. The young birds do not build very effectively for often their nests are somewhat aberrant in form. At the structures they sing and advertise but the nests are never accepted by females and never finished. Occasionally young males fly into colonies of adults and hop about the nests there in very sleeked nervous postures. They are soon chased out by the adults present. The main burst of building was seen at the onset of the monsoon, but a second outbreak occurred in October when some second broods of adult Bayas were in the nest. Thus juvenile Bayas were busy at fresh green nests in bushes projecting above sugarcane stands at a time when most adults were flocking after leaving their colonies. At this season the male juvenile weavers are a dull grey colour with blackish beaks and can be distinguished from post-breeding adults and from juveniles of the year.

VII. SUMMARY

1. The reproductive behaviour of the Baya Weaver (*Ploceus philippinus*) was studied in the Poona area of western India in the monsoon seasons of 1958 and 1959. The work continues studies by other authors on the species in India and recent comparative work on weaver bird behaviour in West Africa.

2. Of 35 colonies studied 82.8% were situated over water and of these 65.7% occurred either within wells or in trees over them. Only six active colonies were found away from water. The survival value of colony siting is discussed.

3. The tertiary sex ratio as determined in the breeding colonies was 1 male : 1.44 females. This excludes from consideration the non-breeding population of males in their first year of life.

4. Each male builds enough nests for his females and usually maintains an extra ' helmet stage nest ' at which he will court any female arriving late in the colony. The numbers of females per territory are shown in Table II. In Table III the numbers of nests per territory and their stages of construction are shown together with the number of females in the territory.

5. The polygamy of the Baya appears to result from the greater availability of females over males in any one breeding season. This is partly due to the failure of males to breed in the first year. Other factors may be important however as the sex ratio of fledgelings is in favour of the males.

6. Males defend small territories around their nest sites. While at first more than one male may build on a nest, mutual hostility soon develops and trespassing is met with aggressive behaviour, the dominant bird at any one site becoming the owner. Occasionally a male may build two nests at once and sometimes these may be in different parts of the colony. In such cases one nest is eventually abandoned and the male's activity concentrated in one place. The size of the territories is influenced by the frequency of suitable nesting sites in a given area.

7. Experimental modification of territories produced the following results :

a. When occupied nests are moved closer together during brooding an increase in threatening behaviour between neighbouring males occurs.

b. If the entrance tube of an occupied nest is tilted so that it opens within the territory of a neighbour, the female owner of the nest cannot enter it nor does the male attempt to fight either member of the pair into whose territory the entrance has been moved. The female of the latter pair however enters it without hesitation. The original owner female is driven out when she attempts to reach her own nest entrance.

c. Unoccupied nests when moved into a neighbouring territory or placed near another male's nest change ownership.

d. Displacement of nests confuses the females who become very anxious, showing much wing flickering, and visit neighbouring nests. This causes fights between females. Neighbouring males respond to the wanderings of the females with supplanting attacks and occasionally with sexual ' greetings ' both of which the females avoid.

e. If occupied nests are kept with reduced distances between them the aggressive responses of the males gradually fade and finally the interactions between the members of the two pairs do not differ from those in unchanged territories. The birds thus adapt themselves quickly to a reduced territory size. The defended area can in fact be reduced to little more than the nest itself.

8. Territories are defended by supplanting attacks, lunges, and Tail depressed Threat. Sequences of aggressive behaviour are analysed and the frequencies of different types related to the contexts in which they occur (see Table V). The occurrence of song is discussed.

9. The pairing process of the Baya occurs in two stages : nest invitation by Advertisement Display and pair bond formation during courtship which includes much sexual chasing. The details of the various displays and other behaviour patterns shown are analysed with comparative reference to the behaviour of other colonial Weavers. The observed behaviour is shown to be due to motivational conflicts between tendencies to respond to the female with sex, attack, and escape. The mutual resolution of these conflicts leads to copulation and pair formation. The detailed descriptive data are shown in Schemes A, B, and C which are further analysed and discussed in the text.

10. Following pair formation, behaviour identical with that shown in the final stages of courtship appears in the ' greeting ' responses between male and established female whenever they meet in their territory. These may include actual courtship sequences and even copulations. The relative strengths of the conflicting tendencies responsible for the postures remain approximately the same after pair formation so long as the male is sexually active in the courtship of fresh females and the earlier pair bonds are maintained.

11. Juvenile birds scatter on leaving the nest and sit still for long periods during which the parents come and feed them. As their flight improves they begin to follow their parents and gradually form loose family groups. These eventually join flocks of other juveniles or mixed flocks of juveniles and adults.

12. In their first monsoon season juvenile males build nests in sites separated from those of adult birds. The colonies of juveniles are small and often isolated nests built by them are seen. Their nest building is defective and females never accept their nests although they may visit them. First year males in early autumn can be distinguished in the field both from breeding females and the young of the year.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the assistance given me by numerous persons throughout the course of these studies. Indeed they would not have been possible without the kindly help I never failed to receive in India.

Dr. Sálim Ali, in particular, has taken a great personal interest in the work at all stages and his detailed knowledge of the species has been a great source of information and renewed initiative. The use of his extensive library whenever required was a kindness I especially appreciated. It was largely due to Dr. Ali that my visit to India became possible and without his help and advice it would have been most difficult to obtain satisfactory results. The success of this endeavour is thus primarily due to him.

Mr. Vijaykumar Ambedkar introduced me to the various colonies around Poona and took part in the investigation at various stages. His assistance in the field on many occasions and his willingness to act as an interpreter helped me greatly at all times. He is at present continuing to work on the breeding biology of the Baya in western India.

On my arrival in Poona Dr. Telford Work, Director of the Virus Research Centre, helped me greatly with certain administrative problems and allowed me to construct aviaries in his garden. Through his assistance I was able to make use of the V.R.C. facilities in numerous practical respects and to benefit greatly, at a later stage, from the help and friendship of his successor Dr. C. Anderson. Dr. Harold Trapido and Dr. Raja Varma also took an interest in the work and were always ready with suggestions and assistance. It was a pleasure to be associated with the work of the V.R.C. on several occasions during my stay.

Mr. John Goatly, regional representative of the British Council in Bombay, gave me much valuable information both before and during my visit to India and did much to help me on several occasions.

I have been in constant correspondence with Dr. W. H. Thorpe, F.R.S., and Dr. Robert Hinde, both of the Zoology Department, Cambridge University. Their continuing advice and encouragement has been of the greatest value. The work is part of a series of Weaver Bird studies financed by the Department of Scientific and Industrial Research, London.

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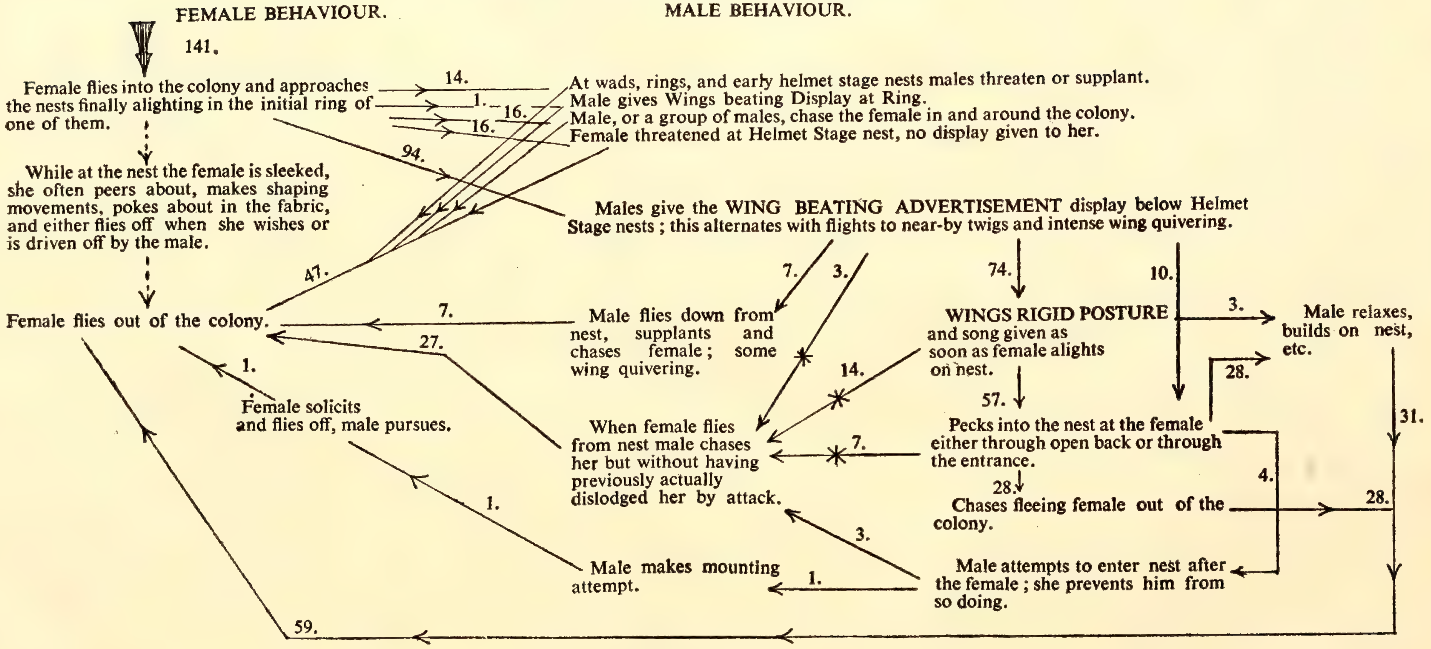
SCHEME A. BEHAVIOUR SEQUENCES DURING NEST INVITATION

COLONIES IN POONA AREA, JULY-AUGUST 1958



FEMALE BEHAVIOUR.

MALE BEHAVIOUR.

Female flies into the colony and approaches the nests finally alighting in the initial ring of one of them.

While at the nest the female is sleeked, she often peers about, makes shaping movements, pokes about in the fabric, and either flies off when she wishes or is driven off by the male.

Female flies out of the colony.

Female solicits and flies off, male pursues.

At wads, rings, and early helmet stage nests males threaten or supplant.

Male gives Wings beating Display at Ring.

Male, or a group of males, chase the female in and around the colony.

Female threatened at Helmet Stage nest, no display given to her.

Males give the WING BEATING ADVERTISEMENT display below Helmet Stage nests; this alternates with flights to near-by twigs and intense wing quivering.

Male flies down from nest, supplants and chases female; some wing quivering.

When female flies from nest male chases her but without having previously actually dislodged her by attack.

Male makes mounting attempt.

WINGS RIGID POSTURE and song given as soon as female alights on nest.

Pecks into the nest at the female either through open back or through the entrance.

Chases fleeing female out of the colony.

Male attempts to enter nest after the female; she prevents him from so doing.

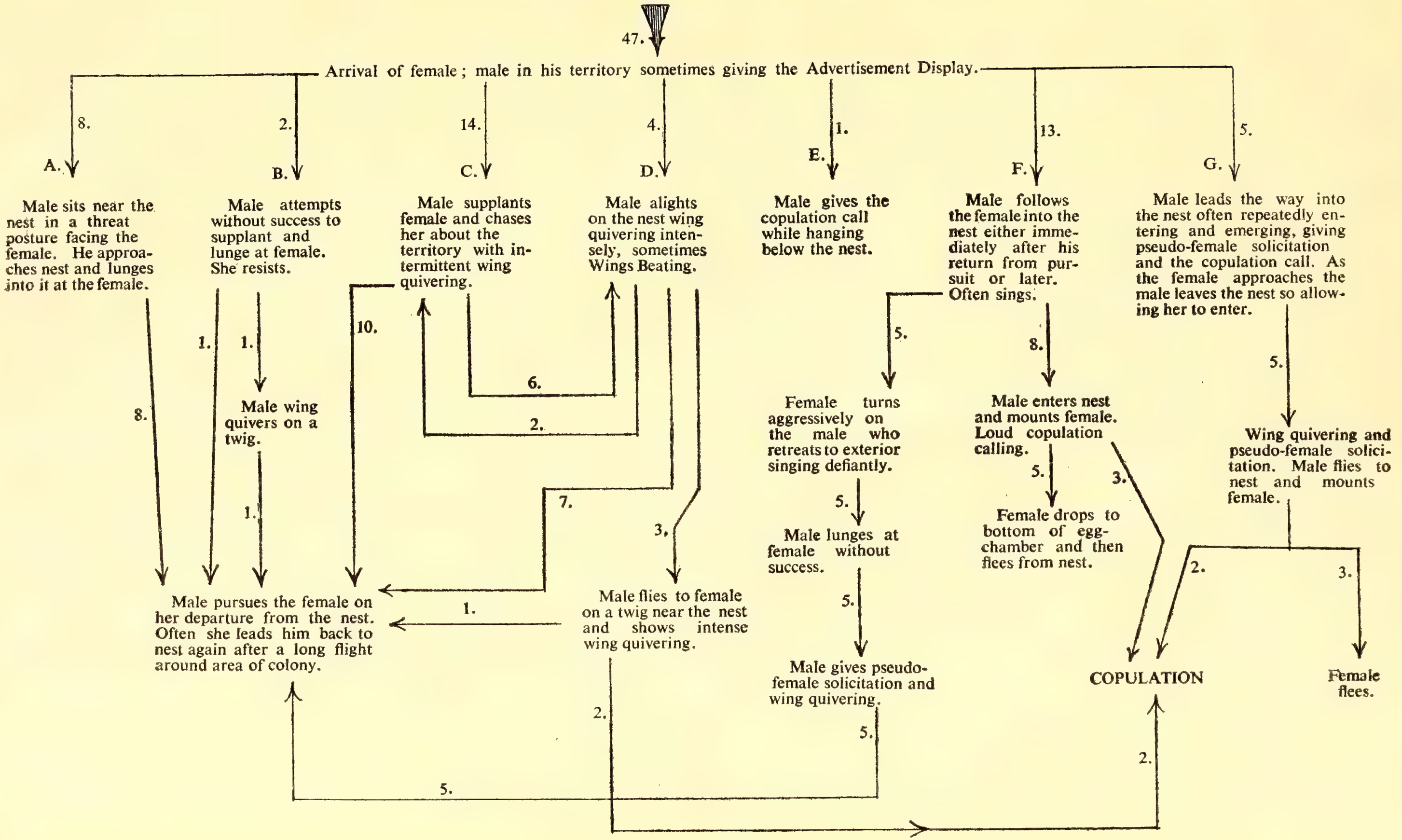
Male relaxes, builds on nest, etc.

* See Text, p. 24

(*NOTE.*—The Scheme is read in the following way : 141 sequences of behaviour have been observed. All start with the females' arrival and then pass through various changes, dependent on the males' varying responses, until her eventual departure. Thus following the arrival of a female at a helmet stage nest the male gave the Advertisement display 94 times and this was followed 74 times by the Wings rigid posture. And so on, see further in text.)

SCHEME B. MALE BEHAVIOUR DURING COURTSHIP AND COPULATION FOLLOWING THE ARRIVAL OF A FEMALE IN HIS TERRITORY

HINGANE COLONY, AUGUST 6TH-8TH, 1958



Arrival of female; male in his territory sometimes giving the Advertisement Display.

A. Male sits near the nest in a threat posture facing the female. He approaches nest and lunges into it at the female.

B. Male attempts without success to supplant and lunge at female. She resists.

C. Male supplants female and chases her about the territory with intermittent wing quivering.

D. Male alights on the nest wing quivering intensely, sometimes Wings Beating.

E. Male gives the copulation call while hanging below the nest.

F. Male follows the female into the nest either immediately after his return from pursuit or later. Often sings.

G. Male leads the way into the nest often repeatedly entering and emerging, giving pseudo-female solicitation and the copulation call. As the female approaches the male leaves the nest so allowing her to enter.

Male wing quivers on a twig.

Female turns aggressively on the male who retreats to exterior singing defiantly.

Male enters nest and mounts female. Loud copulation calling.

Wing quivering and pseudo-female solicitation. Male flies to nest and mounts female.

Male lunges at female without success.

Female drops to bottom of egg-chamber and then flees from nest.

Male pursues the female on her departure from the nest. Often she leads him back to nest again after a long flight around area of colony.

Male flies to female on a twig near the nest and shows intense wing quivering.

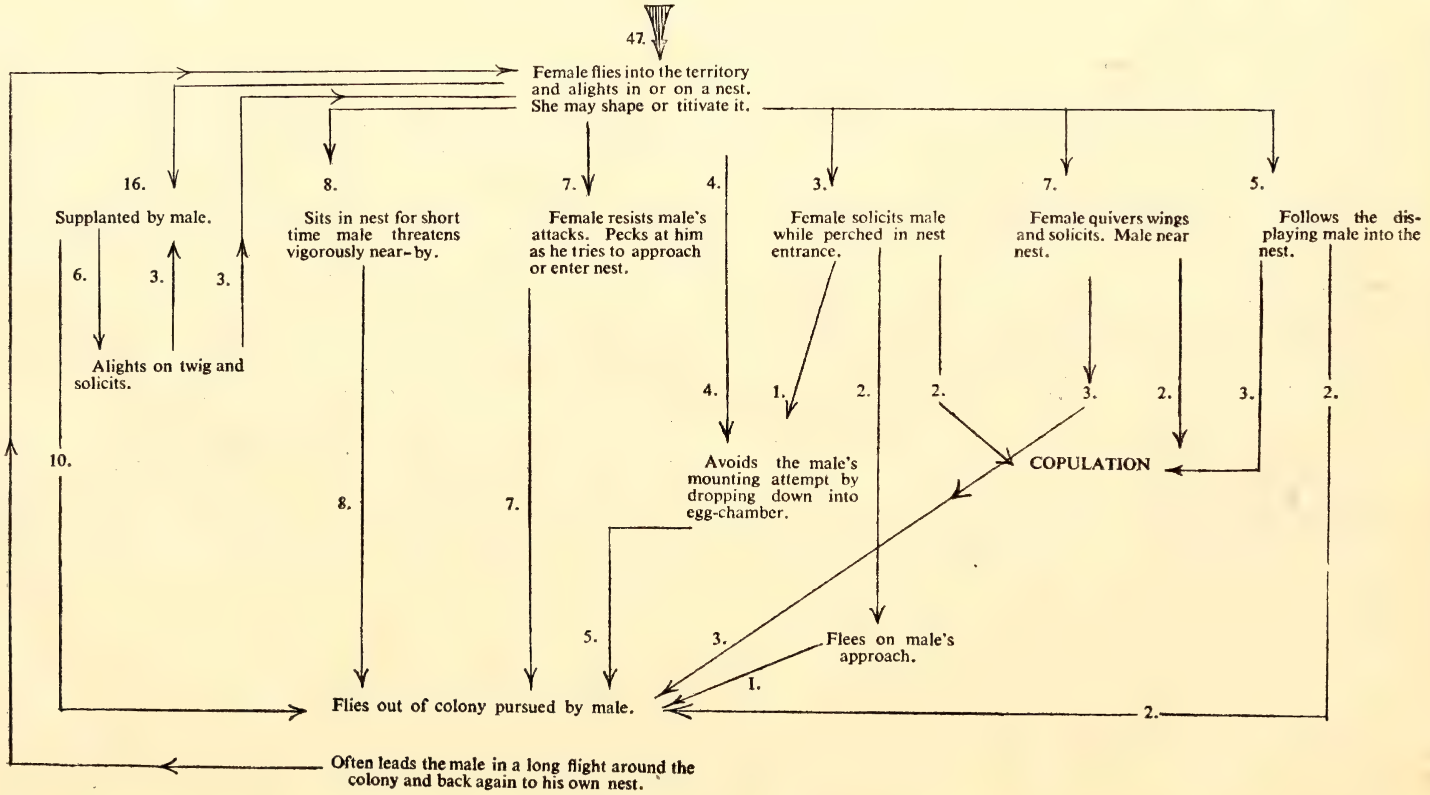
Male gives pseudo-female solicitation and wing quivering.

COPULATION

Female flees.

SCHEME C. FEMALE BEHAVIOUR IN COURTSHIP AND COPULATION FOLLOWING HER ARRIVAL IN A TERRITORY

HINGANE COLONY, AUGUST 6TH-8TH, 1958


47.
Female flies into the territory and alights in or on a nest. She may shape or titivate it.
16.
Supplanted by male.
6.
3.
3.
Alights on twig and solicits.
10.
8.
Sits in nest for short time male threatens vigorously near-by.
8.
7.
Female resists male's attacks. Pecks at him as he tries to approach or enter nest.
7.
4.
4.
Avoids the male's mounting attempt by dropping down into egg-chamber.
5.
3.
Female solicits male while perched in nest entrance.
1.
2.
2.
7.
Female quivers wings and solicits. Male near nest.
3.
2.
5.
Follows the displaying male into the nest.
3.
2.
COPULATION
3.
Flees on male's approach.
1.
2.
Flies out of colony pursued by male.
Often leads the male in a long flight around the colony and back again to his own nest.

Vegetation of Kodaikanal in South India

I. Systematic list of Trees, Shrubs, and Herbs

BY

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INTRODUCTION

Kodaikanal is a beautiful health resort in south India, situated on the southern crest of the Palni plateau in Madurai district, and is visited by numerous tourists, naturalists, and students every year. The height of Kodaikanal is about 6900 ft. while the surrounding hills do not rise beyond 7-8000 ft.

The name ' Kodaikanal ' is derived from the hanging woods situated on the inner side of the basin, the top of which was previously a swamp but was formed into a lake by banking up the stream in 1863. The shape of the lake is like that of a starfish and is about 3 miles round when measured along the level of the road on its margins.

Earlier noteworthy collections from the Palnis have been made by Robert Wight, Lady Bourne, Sir Alfred Fyson, and Gamble. More recently Fr. Pallithanam (1957) gave an account of some of his observations on the flora of Kodaikanal. The present paper gives an account of the plants collected from the area during the author's visit to this hill station.

The floristic composition and status of the shola-grassland formation have been discussed by the author in a separate communication.[1]

VEGETATION

The natural vegetation is of Southern Wet Temperate Forests (Champion 1936) commonly called the *sholas*, which have suffered at the hands of man to a great extent with the result that they are confined to the folds of the hills and have practically vanished except at places where they have been protected by the Forest Department. There are vast stretches of grassland extending all over the area.

Certain exotic species, such as *Acacia decurrens* Willd., *Acacia dealbata* Link, *Acacia melanoxylon* R. Br., *Eucalyptus citriodora* Hook. f., *Eucalyptus filicifolia* F. M. V., *Eucalyptus globulus* Labill., *Pinus insignis* Dunel., *Pinus roxburghii* Sarg., have been planted so as to make the spot attractive for tourists. As many as 35 species of Eucalyptus have been enumerated by Pallithanam (1957). Other exotic plants that have become naturalised in the area are *Cytisus scoparius* Link, *Ulex europaeus* Linn., *Eupatorium glandulosum* H. B. & K., etc. and are found as roadside plants and in the grasslands.

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[1] Ecological Notes on the Vegetation of Kodaikanal. *J. Ind. Bot. Soc.* 39 (in press).

The Bombay and the Tiger sholas have been preserved by the Forest Department from cutting and lopping. Common plants met with in the sholas are *Eugenia calophyllifolia* Wight, *Eugenia arnottiana* Wight, *Ternstroemia japonica* Wight, *Sideroxylon tomentosum* Roxb., *Meliosma wightii* Wall., *Elaeocarpus tuberculatus* Roxb., *Symplocos spicata* Roxb., *Rhododendron nilagiricum* Zenck. There are numerous shrubs, such as *Impatiens phoenicea* Beddome, *Mallotus albus* Muell., *Gaultheria fragrantissima* Wall., *Lobelia excelsa* Lesch., *Berberis tinctoria* Lesch., that cover the ground. There is heavy leaf litter and mould, which when compressed with the hand may measure 3 to 4 inches.

In the grasslands common species present are *Eragrostis nigra* Nees, *Cymbopogon confertiflorus* Stapf, *Andropogon micranthus* Kunth., *Chrysopogon wightianus* Nees, *Brachypodium sylvaticum* Beauv., etc. These grasslands are invaded by a number of species from the roadsides, such as *Osbeckia wightiana* Benth., *Rhododendron nilagiricum* Zenck., *Erigeron linifolius* Willd., *Rhodomyrtus tomentosa* Wight. Other roadside plants, such as *Lycopodium cernuum* Linn., *Helichrysum bracteatum* Andr., *Crotalaria scabrella* Wight & Arn., *Alysicarpus rugosus* DC., *Dipsacus leschenaultiana* Coult., *Anaphalis beddomei* Hook. f., *Ageratum conyzoides* Linn., *Artemisia nilagirica* Pamp., *Taraxacum officinale* Linn., *Wahlenbergia gracilis* DC., *Swertia corymbosa* Wight, *Cynoglossum furcatum* Wall., *Verbascum thapsus* Linn. are not uncommon in these grasslands.

LIST OF THE PLANTS COLLECTED

The plants given in the following list have been collected from the area and are preserved in the herbarium of the French Institute at Pondicherry. The nomenclature followed is the one given by Fyson except for some recent nomenclatural changes as given by Raizada (1958). After the name of each plant, whenever possible, reference is given to Fyson's FLORA. Thus *Naravelia zeylanica* DC. (Fyson 1 : 4) means that this plant is described in Fyson's FLORA OF THE SOUTH INDIAN HILL STATIONS Vol. 1, page 4. Plants marked with an asterisk have not been described by Fyson.

Ranunculaceae

Naravelia zeylanica DC. (Fyson 1 : 4)

A climbing shrub with numerous white flowers in compound panicles. Climber in sholas.

Ranunculus muricatus Linn. (Fyson 1 : 3)

A small herb with broad leaves and with conspicuous spines on achenes. Flowers yellow. From Kodaikanal near a stream.

Ranunculus subpinnatus Wight & Arn. (Fyson 1 : 7)

An erect tufted herb with large yellow flowers. Between 6000-7500 ft. Kodaikanal.

Magnoliaceae

Michelia champaca Linn. (Fyson 1 : 11)

A tall tree with fragrant yellow flowers. Between 3000-5500 ft. near Kodaikanal, occasionally found in gardens.

Berberidaceae

Berberis tinctoria Leschenault. (Fyson 1 : 15)

A shrub with yellow flowers in drooping racemes. The plant is not similar to *Berberis aristata* found in the western Himalayas

Mahonia leschenaultii Takeda. (Fyson 1 : 16)

A big shrub with slender or stout branches. Sometimes almost a tree. Flowers yellow in dense terminal racemes or spikes.

Nymphacaceae

Nymphaea stellata Willd. (Fyson 1 : 18)

An aquatic herb with blue flowers. The only species seen by me in the Kodaikanal lake.

Cruciferae

***Lobularia maritima** Desv.

A cultivated herb growing in the garden of La Providence.

***Cheiranthus cheiri** Linn.

A cultivated herb grown for the flowers.

Violaceae

Viola partrinii DC. (Fyson 1 : 26)

A small herb with stout rootstock and white flowers. Common in the open downs, in grasses in shady places ; also in the Himalayas.

Bixaceae

***Cochlospermum gossypium** DC.

A small tree with tomentose branchlets with a few golden yellow flowers. Common on the roadsides in the lower hills.

Scolopia crenata Clos. (Fyson 1 : 28)

A tree with browny young branches and yellow flowers in racemes. Common on the roadsides at lower levels.

Polygalaceae

Polygala javanica DC. (Fyson 1 : 34)

A small loosely-branched undershrub. Flowers with yellow wings and pink keel. Common on Kodaikanal hills.

Polygala sibirica Linn. (Fyson 1 : 35)

A small herb with many stems and pinkish flowers in short racemes from the axils of upper leaves. Very common on the cattle tracts in grasses at 7000 ft.

Hypericaceae

Hypericum mysorense Heyne. (Fyson 1 : 46)

A shrub with four-angled wings and yellow flowers at the end of branches solitary or in threes. Very common on the roadsides invading grasslands on poor soils.

Ternstroemiaceae

Eurya japonica Thunb. (Fyson 1 : 53)

A big tree with straight stem. Flowers pale yellow, fragrant, from the axils of fallen leaves. Common in the sholas, also found in the western Himalayas.

Sterculiaceae

***Waltheria indica** Linn.

A perennial villous herb with yellow flowers at 5000 ft. in Kodaikanal.

Elaeocarpaceae

***Elaeocarpus tuberculatus** Roxb.

A tree with leaves glabrous above and hairy along the nerves beneath. Flowers yellow, petals silky outside, in racemes. A common tree of the sholas.

Elaeocarpus ferrugineus Wight. (Fyson 1 : 65)

A tree with brownish green foliage. Leaf like an inverted boat. Flowers in racemes. Common in the sholas at high levels.

Elaeocarpus oblongus Gaertner. (Fyson 1 : 65)

A middle-sized tree with white stem, twigs with conspicuous lenticels. Flowers with white petals in racemes in the axils of fallen leaves. Very common in the sholas near Kodaikanal at 6000 ft.

Geraniaceae

***Pelargonium zonale** Ait.

A herb commonly cultivated for its flowers in gardens.

***Pelargonium graveolens** L'Her.

A fragrant-leaved bushy plant, cultivated in gardens for its flowers.

Oxalis tetraphylla Cav. (Fyson 1 : 74)

Herb with four leaflets. Flowers pink or red on the upper side and white on the lower. A common weed at 7000 ft.

Biophytum candolleanum Wight. (Fyson 1 : 77)

A small woody plant with yellow flowers. Common in shady places at 6000 ft.

Impatiens phoenicea Cav. (Fyson 1 : 96)

A slender herb with dark green elliptic leaves and red flowers. Common plant in the sholas.

Impatiens tomentosa Heyne. (Fyson 1 : 88)

A branched herb with yellowish white flowers having magenta-coloured wings spotted with dark purple near the crimson base. Quite common on the downs at 7000 ft.

Rutaceae

Toddalia asiatica Lamk. (Fyson 1 : 100)

A prickly shrub with white flowers in close axillary corymbose panicles. Very common in the sholas extending down to the plains in dry forests.

***Atalantia ceylanica** Oliv.

A shrub, armed with prickly spines. Leaflets notched. Flowers shortly racemed. Common in the lower hill near Kodaikanal.

Meliaceae

Toona ciliata Roem. Syn. *Cedrela toona* Roxb. (Fyson 1 : 105)

A handsome tree with large pinnate leaves ; flowers white in axillary branched panicles. A dominant tree of the low level sholas at 5000 ft. below Kodaikanal. Also found in the Himalayas.

Aquefoliaceae

* **Ilex malabarica** Bedd.

A large glabrous tree with narrowly elliptic oblong leaves. Male flowers in shortly panicled umbellules. In the sholas at low level.

Celastraceae

Euonymus crenulatus Wall. (Fyson 1 : 110)

A small tree with yellowish green leaves and purplish brown flowers. Quite common in the sholas.

Rhamnaceae

Zizyphus rugosa Lamk. (Fyson 1 : 117)

A large straggling shrub armed with solitary curved spines. Flowers greenish yellow in long peduncled cymes on leafless branches. On roadsides at 6500 ft.

Sapindaceae

Dodonaea viscosa Linn. (Fyson 1 : 128)

A shrub with lenticelled stem and flowers in terminal cymose branches. In open places and edges of the sholas below Kodaikanal.

* **Sapindus emarginatus** Vahl.

A moderate-sized tree with pinnate leaves. Flowers white axillary or terminal. Common near Kodaikanal in the low level sholas.

Anacardiaceae

* **Buchanania angustifolia** Roxb.

A tree with black brown bark, tesellated with deep irregular cracks. Common in the forests of lower hills.

Sabiaceae

Meliosma wightii Planch. (Fyson 1 : 130)

A tree with dark green foliage and cream-coloured flowers in branched panicles. Common tree in the sholas on Kodaikanal downs.

Meliosma microcarpa. (W. A.) Craib. Syn. *Meliosma arnottiana* Wight. (Fyson 1 : 131)

A round-topped tree with dark green foliage with broad cream-coloured bases of flowers. Common tree in the sholas at 5000 ft.

Leguminosae

Cytisus scoparius Link. (Fyson 1 : 138)

A herb with very dark green foliage and solitary yellow flowers in the axils of the leaves. A very common herb on the roadsides invading the grasslands.

Crotalaria fysonii Dunn. (Fyson 1 : 144)

A small plant with large yellow flowers at the end of branches. Common on the roadsides spreading over paths and cattle tracts.

Crotalaria scabrella Wight & Arn. (Fyson 1 : 141)

A small shrub with hard, stiff branches and yellow flowers. On roadsides in long grass on the open downs.

Crotalaria semperflorens Vent. (Fyson 1 : 149)

A shrub with large ear-shaped stipules and yellow flowers in spikes. Common on the roadsides and edges of the sholas above Kodaikanal.

***Alysicarpus rugosus** DC.

An ascending herb with glabrous stem ; leaflets 3. Flowers in dense racemes. Pods 3-5 jointed.

Dumasia villosa DC. (Fyson 1 : 165)

A climber with 3-foliate leaves and yellow flowers in short racemes. On the downs in sholas.

Trifolium repens Linn. (Fyson 1 : 153)

A herb with white flowers in heads. Cultivated for animal food, here as an escape.

Mucuna hirsuta Wight & Arn. (Fyson 1 : 166)

A climbing herb with obliquely ovate leaves. Flowers reddish purple. Fruit densely covered with hairs, having irritating properties.

Ulex europaeus Linn. (Fyson 1 : 136)

A thorny shrub with bright yellow flowers. Very common on the roadsides, as an escape and spreading quickly.

Acacia melanoxylon R. Br. (Fyson 1 : 186)

A tree 50-75 ft. planted everywhere on the roadsides.

Acacia decurrens Willd. (Fyson 1 : 186)

The plant is commonly planted everywhere near Kodaikanal.

Acacia dealbata Link. (Fyson 1 : 186)

A plant cultivated all around Kodaikanal.

Rosaceae

Rubus racemosus Roxb. (Fyson 1 : 195)

A shrub with branches and inflorescence covered with glandular hairs. Flowers white. On the downs at Kodaikanal.

Rubus ellipticus Smith. (Fyson 1 : 193)

A shrub covered with white tomentum. Flowers yellow. In open downs near Kodaikanal; also common in the Himalayas.

Fragaria indica Andr. (Fyson 1 : 197)

Herb with slender runners and yellow flowers. Common at Kodaikanal and in the Himalayas near water in shady place.

Myrtaceae

Baeckea virgata Anders. (Fyson 1 : 216)

A loosely-branched shrub with flowers in the upper axils at Kodaikanal 7000 ft.

***Syzygium cumini** (Linn.) Skeels. Syn. *Eugenia jambolana* (Fyson 1 : 222 under *Syzygium jambolanum*)

A large spreading tree with numerous flowers in cymes. Common tree of the sholas below Kodaikanal.

Eucalyptus globulus. Labill. (Fyson 1 : 217)

A tree cultivated extensively near Kodaikanal.

Eucalyptus citriodora Hook. (Fyson 1 : 217)

A tree with drooping branches and slender leaves. Cultivated near Kodaikanal.

Eucalyptus filicifolia F.M.V. (Fyson 1 : 217)

A small tree with finely pointed leaves and red flowers. Cultivated near Kodaikanal.

Rhodomyrtus tomentosa Wight. (Fyson 1 : 218)

A round-topped shrub with green foliage and pink flowers in cymose axillary corymbs. Common on the roadsides and dry slopes.

Melastomaceae

Osbeckia wightiana Benth. (Fyson 1 : 226)

A shrub with hairs on the branches. Flowers purple. Common on the roadsides and downs up to 4000 ft.

Onagraceae

Fuchsia corymbiflora Ruiz & Pav. (Fyson 1 : 237)

A shrub cultivated in the gardens at Kodaikanal.

Passifloraceae

Passiflora leschenaultii DC. (Fyson 1 : 240)

A climber with semicircular leaves and white flowers. Common on the shola trees.

Umbelliferae

Bupleurum distichophyllum Wight & Arn. (Fyson 1 : 251)

A herb with grass-like leaves and yellow flowers on open downs above Kodaikanal.

Bupleurum mucronatum Wight & Arn. (Fyson 1 : 250)

A herb with linear-oblong leaves and yellow flowers at 7000 ft. The plant is different from *B. falcatum* found in the Himalayas.

Heracleum sprengelianum Wight & Arn. (Fyson : 1 : 257)

A large herb with yellow flowers and elliptic mericarps. In the grass on the downs.

Heracleum ceylanicum Gard. (Fyson 1 : 256)

Herb with longer than broad leaves and pure white flowers. In the moist valleys.

Araliaceae

Schefflera racemosa Harms. (Fyson 1 : 260)

A medium-sized tree with 7-9 leaflets spreading star-like and white flowers in axillary compound spikes. Common in the sholas.

Caprifoliaceae

Viburnum erubescens Wall. (Fyson 1 : 265)

A roadside shrub with white-barked branches and cream-coloured flowers.

Viburnum coriaceum Blume. (Fyson 1 : 263)

A small tree with lenticelled twigs and yellowish white flowers. On the downs below and above Kodaikanal.

Rubiaceae

Oldenlandia stylosa O.Kze. (Fyson 1 : 272)

A shrub with flexuous branches and white flowers. In cool and shady places near sholas.

Oldenlandia articularis Gamble (Fyson 1 : 272)

Shrub with narrow leaves and white flowers in terminal compact cymes. In shady places on the downs.

Oldenlandia swertioides O.Kze. (Fyson 1 : 273)

A shrub with stiff ovate leaves and flowers in dense pubescent cymes. Common on the downs above Kodaikanal.

***Anotis calycina** Hook.f.

A small herb covered with soft hairs. Flowers white in terminal cymes with a pair of leaves just below. In moist and shady places.

Anotis wightiana Wall. (Fyson 1 : 276)

A perennial herb clothed with soft curly hairs. Flowers white-blue, shortly pedicelled; at 6000 ft. at Kodaikanal.

Psychotria congesta Wight & Arn. (Fyson 1 : 287)

A glabrous shrub with oblanceolate leaves and white flowers in terminal panicles. Common shrub in sholas, in downs.

Rubia cordifolia Linn. (Fyson 1 : 294)

A slender climbing herb. Flowers in axillary cymes on short axillary branches. Common in thickets at Kodaikanal.

Galium asperifolium Wall. (Fyson 1 : 295)

A herb with rough and 4-angled stems climbing on bushes. Flowers small. Above Kodaikanal on the downs.

Mussaenda hirsutissima Hutch. (Fyson 1 : 279)

A hairy shrub. Sepals white leaf-like. Corolla ornage-brown. Abundant on lower slopes up to 6000 ft.

Dipsaceae

Dipsacus leschenaultiana Coult. (Fyson 1 : 298)

A large herb. Stems hollow. Flowers whitish in heads. Above Kodaikanal in downs. Flowers not seen. In the Himalayas another species, *Dipsacus inermis*, is very common at the same altitude.

Compositae

Vernonia conyzoides DC. (Fyson 1 : 313)

A low herb usually unbranched till near flowering region. Heads few in spreading corymbs. Below Kodaikanal near the sholas.

Vernonia monosis Benth. (Fyson 1 : 308)

A tree with densely tomentose young parts. Flowers mauve coloured. In sholas at Kodaikanal at 7000 ft., commonly on the borders.

Vernonia saligna DC. (Fyson 1 : 312)

A herb with numerous heads in branched rounded cymes. Downs just below Kodaikanal.

Anaphalis neelgerriana DC. (Fyson 1 : 334)

A herb, leaves bluish white coated with soft white cotton. Heads in open corymbose panicles. Common on roadsides. There are several other species of *Anaphalis* in the Himalayas, but not the ones in Kodaikanal.

Anaphalis beddomei Hook. f. (Fyson 1 : 328)

A decumbent herb with branches curving upwards. Flower heads in small corymbs on peduncles. Common on the downs at Kodaikanal.

Anaphalis leptophylla DC. (Fyson 1 : 333)

A herb with linear leaves. Heads pure white with yellow centre. In damp and shady places near Kodaikanal.

Ageratum conyzoides Linn. (Fyson 1 : 315)

A hairy herb with light purple florets. Common on roadsides.

***Myriactis wallichii** DC.

A small herb with oblanceolate leaves and yellow heads. Near Kodaikanal, common.

Conyza ambigua DC. (Fyson 1 : 322)

A herb with narrow linear leaves. Heads with pale florets. A common weed.

Bidens pilosa Linn. (Fyson 1 : 339)

An erect herb with four-angled stem and three-foliate leaves. Flowering portion forked cymosely, involucral bracts with scarious margins, Ray florets yellow or white. A roadside weed.

Gnaphalium hypoleucun DC. (Fyson 1 : 334)

A herb with lanceolate leaves. Flowers golden coloured.

***Cnicus wallichii** DC.

An erect herb with spine-toothed leaves, decurrent down the stem. Florets purple, tubular, in terminal heads on short axillary, leafy branches, forming a terminal corymbose panicle. Near golf links.

Moonia heterophylla Arn. (Fyson 1 : 337)

An annual herb. Flower heads in irregular umbels. Ray florets white, inner yellow. Common in sholas.

Artemisia nilagirica Pamp. (Fyson 1 : 341) (=*A.vulgaris* Auct., non Linn.)

Herbs with leaves white tomentose on under surface. All florets fertile. Common in Kodaikanal downs in dense patches.

Artemisia parviflora Roxb. (Fyson 1 : 342)

A shrub-like herb with small heads and few florets. Common in downs.

Taraxacum officinale Linn. (Fyson 1 : 356)

A herb with strong rootstock, florets yellow in solitary heads on hollow scapes. A common weed at Kodaikanal and in the Himalayas up to 10,000 ft.

Erigeron mucronatum DC. (Fyson 1 : 320)

A herb with slender branches. Flower heads solitary, terminal, white when young, pinkish when old. Kodaikanal, on roadsides.

Siegesbeckia orientalis Linn. (Fyson 1 : 338)

Pubescent herb. Heads terminal. Florets yellow.

Galinsoga parviflora Roxb. (Fyson 1 : 339)

An annual herb with small heads on slender stalks of unequal length. Common in damp and shady places in sholas.

Campanulaceae

Wahlenbergia gracilis DC. (Fyson 1 : 361)

A perennial herb with linear lanceolate leaves and blue flowers. Common in grass in open downs near and above Kodaikanal.

Lobeliaceae

Lobelia excelsa Lesch. (Fyson 1 : 359)

A tall herb. Flowers in dense purplish brown spikes. Near sholas and roadsides, very common.

Vacciniaceae

Vaccinium nilgherense Wight. (Fyson 1 : 365)

A large shrub with narrow leaves, white flowers, and compressed fruits. Common at Kodaikanal.

Ericaceae

Gaultheria fragrantissima Wall. (Fyson 1 : 366)

A shrub with snow-white flowers in axillary racemes. Very common at edges of sholas near Kodaikanal.

Rhododendron nilagiricum Zenck. (Fyson 1 : 368)

A small tree with rough elliptical leaves erect in bud. Flowers crimson coloured. Very common, conspicuous by its red flowers like the *Rhododendron arboreum* in the Himalayas.

Myrsinaceae

Maesa perrottetiana DC. (Fyson 1 : 373)

A shrub with lenticelled twiggy branches. Flowers in slender racemes. Common plant of the sholas at low levels.

Styracaceae

Symplocos foliosa Wight. (Fyson 1 : 382)

A tree with lumpy foliage and white flowers in short axillary spikes. In sholas near Kodaikanal.

Symplocos laurina (Retz.) Wall. ex G. Don. Syn. *Symplocos spicata* Roxb. (Fyson 1 : 381)

A tree with thick glossy leaves and white yellow flowers in axillary spikes. On downs above Kodaikanal.

Oleaceae

Olea glandulifera Wall. (Fyson 1 : 389)

A tree with grey and lenticelled branches. Flowers in regular decussately-branched panicles. In the sholas.

Ligustrum roxburghii C.B. Clarke. (Fyson 1 : 391)

A small tree with large acuminate leaves and creamy-white flowers in axillary and terminal compound panicles. In low level sholas.

Apocynaceae

***Vinca major** Linn.

An erect herb with purplish flowers. On the walls on roadsides at Kodaikanal.

Loganiaceae

***Buddleia asiatica** Lour.

An erect shrub with lanceolate leaves and flowers in axillary and terminal panicled cymes.

Gentianaceae

Exacum wightianum Arn. (Fyson 1 : 407)

A tall herb with violet blue flowers. In open downs near Kodaikanal.

Swertia corymbosa Wight. (Fyson 1 : 410)

A small herb, flowers white with darker veins in umbel-like inflorescence. Very common in open downs.

Boraginaceae

Cynoglossum furcatum Wall. (Fyson 1 : 413)

A herb with lanceolate leaves and blue or pink flowers in spikes. In the open downs.

Convolvulaceae

Argyreia nellygherrya Choisy. (Fyson 1 : 415)

A climber with silvery hairs on green parts. Flowers pale purple. Kodaikanal at 5000 ft.

Solanaceae

Solanum nigrum Linn. (Fyson 1 : 419)

A small herb with white flowers and black fruits. Roadside weed in damp and shady places.

***Solanum jasminoides** Paxt.

A climbing shrub with white flowers, at 7000 ft.

Solanum laeve Dunal. (Fyson 1 : 419)

A small shrub with geniculate branches. Flowers white in axillary branches.

***Cestrum fasciculatum** Miers.

An elegant garden plant, 7000 ft.

Scrophulariaceae

Verbascum thapsus Linn. (Fyson 1 : 425)

A stout herb, with yellow flowers in densely woolly spikes. A weed of waste places.

Digitalis purpurea Linn. (Fyson 1 : 429)

A herb with pink flowers in tall terminal spikes. Common in Kodaikanal as a garden escape.

Antirrhinum majus Linn.

Cultivated in the garden of La Providence for its flowers.

Acanthaceae

Strobilanthes kunthianus T. Anders. (Fyson 1 : 445)

A shrub with pale blue flowers in dense spikes, flowering only every 7-12 years. Common on open hillsides covering large areas.

Strobilanthes luridus Wight. (Fyson 1 : 451)

A straggling shrub with flowers in erect spikes on old branches with broad bracts. In the sholas.

Rungia laeta Clarke. (Fyson 1 : 458)

A herb with terete stem. Flowers in axillary racemes.

Andrographis neesiana Wight. (Fyson 1 : 454)

Shrub with flowers in one-sided racemes in the axils of upper and smaller bract-like leaves. On the downs.

***Blepharis maderaspatensis** (Linn.) Heyne ex Roth. Syn. *Blepharis boerhaviaefolia* Pers.

A prostrate herb with axillary spikes. Flowers pink. At Kodaikanal, at 6000 ft.

Verbenaceae

Lantana aculeata Linn. (Fyson 1 : 459)

A strongly scented shrub, with recurved prickles on the angles of branches. Flowers orange, red, or pink. Naturalized and troublesome.

***Stachytarpheta indica** Vahl.

A herb with flowers in long spikes. Corolla tubular pink. A garden escape.

Clerodendrum serratum Moon. (Fyson 1 : 461 under *Clerodendron serratum* Spreng.)

A shrub; flowers blue with a conspicuously wide oblique mouth. Common on the slopes near Kodaikanal.

***Verbena citriodora** H. & B. & K.

A cultivated shrub. In garden of La Providence.

Labiatae

Pogostemon speciosus Benth. (Fyson 1 : 472)

An undershrub with flowers in terminal spikes. In cool and shady places on the outskirts of sholas.

Pogostemon heyneanus Benth. (Fyson 1 : 471)

An aromatic shrub with slender spike. Near Kodaikanal often cultivated.

Micromeria biflora Benth. (Fyson 1 : 474)

A small herb with pink purple flowers in small cymes in the axils of the leaves. Common all over in grass.

Scutellaria violacea Heyme. (Fyson 1 : 476)

A herb with white flowers tinged with purple in spikes. Common in moist and shady places.

***Salvia patens** Cav.

A garden plant. Cultivated often for its flowers.

***Salvia farinacea** Benth.

A garden plant. Cultivated for the flowers.

Leucas angularis Benth. (Fyson 1 : 480)

A straggling herb with few white flowers. Common on shrubs and small trees.

Leucas suffruticosa Benth. (Fyson 1 : 480)

An undershrub; under surface of the leaves white. Flowers white. Common in the grass of the downs.

Leucas hirta Spreng. (Fyson 1 : 483.)

A herb with elliptic, obscurely-toothed leaves. Flowers white.

Plantaginaceae

***Plantago major** Linn.

A perennial herb with stout rootstock. Flowers in spikes. Cultivated in gardens.

Amaranthaceae

Achyranthes bidentata Bl. (Fyson 1 : 487)

A herb similar to *Achyranthes aspera* but the bracteoles of the flowers are reduced to spines. Common herb in the sholas.

Polygonaceae

Polygonum chinense Linn. (Fyson 1 : 493)

A shrub-like herb with white or pinkish flowers. Very common in the rich cool soil.

Piperaceae

Piper brachystachyum Wall. (Fyson 1 : 499)

A small herb. Leaves elliptic, narrower than long, with 4 side-veins. Male spikes slender. Female spikes smaller than male, about ¼″, erect in fruit. Common on the sholas near Kodaikanal.

Piper schmidtii Hook. f. (Fyson 1 : 500)

A small herb with ovate elliptic leaves. Flowers in male and female spikes. Near Kodaikanal, common in sholas. Berry red or yellow.

Piper wightii Miq. (Fyson 1 : 500)

A herb with stout branches and broad leaves with 5-7 nerves near the base. Spike stout, bracts with prominent sinuate margins. Below Kodaikanal and in Bombay shola.

Lauraceae

Cinnamomum wightii Meissn. (Fyson 1 : 503)

A large tree with light green foliage. Flowers in open panicles. Common tree of the sholas.

Litsea wightiana Wall. (Fyson 1 : 507)

A moderate tree with coriaceous leaves. Common in sholas.

Thymelaeaceae

***Lasiosiphon eriocephalus** Decne.

A shrub with slender twigs. Flowers in terminal heads, nearly globular. In sholas at 6000 ft.

Elaeagnaceae

Elaeagnus kologa Schlecht. (Fyson 1 : 511)

A straggling shrub, covered with silvery scales and with spiny branchlets at the angles of main bracts. Flowers in clusters of 4-5 in leaf axils. Common in sholas.

Santalaceae

Osyris wightiana Wall. ex Wight Syn. *Osyris arborea* Wall. (Fyson 1 : 522)

A shrub with angular and green branchlets. Fruit a yellow-orange berry. In sholas and downs.

Euphorbiaceae

Mallotus albus Muell. var. **occidentalis** Hook. f. (Fyson 1 : 535)

An evergreen tree with young parts covered densely with tomentum. Flowers in terminal panicles. Below Kodaikanal very common at 6500 ft.

***Bischoffia javanica** Blume

A round-headed, glabrous tree with green flowers in panicles. Males minute on slender pedicels, females on stout pedicels.

Euphorbia rothiana Spr. (Fyson 1 : 527)

A herb with narrow leaves, one-nerved. Flowering branches 3-5, tufted once or twice. On margins of sholas in shady places on damp soil.

Phyllanthus rheedii Wight. (Fyson 1 : 528)

An annual undershrub with slender reddish stem. Male flowers 2-3 at a node, females solitary. Common near Kodaikanal.

Urticaceae

Trema orientalis Bl. (Fyson 1 : 539)

A tree with ovate leaves, nerves joined by many cross veins, lower surface white with silvery pubescence. On slopes below Kodaikanal.

Orchidaceae

Oberonia wightiana Lindl. (Fyson 1 : 562)

An epiphyte, pale yellowish green flowers. On shola trees at Kodaikanal.

Aerides ringens Fischer. (Fyson 1 : 579)

An epiphytic orchid with strongly grooved leaves often spotted brown. Flowers in spikes. On shola trees.

Saccolabium filiforme Lindley. (Fyson 1 : 581)

An epiphytic herb with slender green stem, stick-like leaves, and yellow-brown flowers in drooping spikes. Frequent in sholas.

Spiranthes australis Lindley. (Fyson 1 : 583)

A small terrestrial orchid with flowers in dense spirals. Common in grass all over the downs.

Liliaceae

Lilium neilgherrense Wight. (Fyson 1 : 611)

A peculiar herb with narrow lanceolate leaves and single, bell-shaped, pendulous flower. Common in open downs.

Commelinaceae

Commelina clavata Clarke. (Fyson 1 : 615)

Herbs with slender stem. Flowers blue in small cymes sheathed in a large heart-shaped bract. On downs below Kodaikanal.

Cyanotis pilosa Schultes. (Fyson 1 : 617)

Herbs with thick rootstock. Flowers in clusters. On slopes above Kodaikanal.

Cyanotis arachnoidea Clarke. (Fyson 1 : 618)

Sprawling herbs, covered with white hairs. Flowers in terminal cymes with a leaf or bract just below. In dry places above Kodaikanal.

Araceae

Arisaema leschenaultii Blume. (Fyson 1 : 623)

A herb with stem mottled with brownish purple marks. Spadix straight not projecting beyond the mouth. Female spadix with hair-like projections. On roadsides in cool and shady places.

Cyperaceae

Fimbristylis paupercula Boeck. (Fyson 1 : 639)

A herb with short rhizome and tufted stem. Spikelets in an irregular umbel. Common on the dry slopes.

Fimbristylis kingii Clarke. (Fyson 1 : 638)

A herb with short rhizome at 7000 ft. in Kodaikanal.

Carex baccans Nees. (Fyson 1 : 650)

A grass-like herb with stout rhizome and tall stem. Spikes 1½-2″, upper flower male, in large panicle. Utricle ribbed strongly. Shola at 7000 ft.

Graminaceae

Oplismenus compositus Beauv. (Fyson 1 : 659)

A weak-stemmed grass with thin flat leaves. Spikelets in short spikes. Very common in the sholas.

Ischaemum ciliare Retz. (Fyson 1 : 664)

A coarse grass with elliptic, acute leaves. Flowering stem slender and purplish upwards. Spikes two diverging. In Kodaikanal on the open downs.

***Ischaemum aristatum** Linn.

A perennial grass. At 7000 ft.

Chrysopogon wightianus Nees. (Fyson 1 : 666)

A grass with tufted stem, glumes red, anthers yellow. Awns long and bent. In and near Kodaikanal.

Chrysopogon zeylanicus Th. (Fyson 1 : 667)

A grass with a stout rootstock. Leaves narrow, pubescent with slender greenish branches. Near Kodaikanal on the downs.

Heteropogon contortus Beauv. (Fyson 1 : 668)

A grass with stem about 1 ft. densely tufted. Leaves rigid. Spikelets terminal solitary. Abundant near Kodaikanal.

Cymbopogon confeltiflorus Stapf. (Fyson 1 : 669)

A grass with 3-4 ft. stem. Glume of the sessile spikelet shallow. In and around Kodaikanal.

Anthistiria ciliata Linn. (Fyson 1 : 671)

A tall annual grass. Leaf blade ciliate near the base with hairs on bulbous bases. On the downs above Kodaikanal.

Anthoxanthum odoratum Linn. (Fyson 1 : 671)

A sweet-scented grass with a rhizome. In the woods near Kodaikanal.

Sporobolus indicus Br. (Fyson 1 : 672)

A grass with narrow leaves and long spike-like panicles, branches of which are closely covered to the base with small spikelets and erect close to the stem. Very common near Kodaikanal.

Avena aspera Munro. (Fyson 1 : 674)

A grass with flat leaves, stem purplish ending in a narrow panicle of erect spikelets. Near Kodaikanal.

Bromus asper Murray. (Fyson 1 : 680)

A grass with slender stem 2-3 ft. Leaves slender. In moist places near and below Kodaikanal.

Brachypodium sylvaticum Beauv. (Fyson 1 : 681)

A perennial grass, stem 2-4 ft. Leaves narrow spike 2-6″ nodding its axis flattened. In the downs of Kodaikanal.

Coniferae

***Pinus roxburghii** Sargent.

A large tree with thick and furrowed bark. Leaves triquetrous, light green. Planted rarely in Kodaikanal.

Lycopodiaceae

***Lycopodium cernuum** Linn.

A small herb, very common on the roadsides at Kodaikanal.

ACKNOWLEDGEMENTS

The author is deeply indebted to Prof. P. Legris for his valuable suggestions and for excellent facilities provided during the author's tours; to Rev. Fr. H. Santapau for his criticism and perusal of the manuscript; and to Dr. G. S. Puri, Regional Botanist, Botanical Survey of India, Poona, for his kind help and suggestions during the course of the work.

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Fishes from the Kashmir Valley[1]

BY

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(*With two plates*)

In March-April 1954 the late Dr. Sunder Lal Hora visited the Kashmir Valley and made an extensive collection of fishes, which on his return to Calcutta he kindly passed on to me for study. As regards the topography of the Kashmir Valley and its drainage, he wrote that the Valley is 'about eighty miles long, about twenty to twenty-five miles broad, and on the average rising about 6000 ft. above sea-level. It is flanked on almost all sides by snow-capped mountains. The Jhelum River which originates in its south-eastern corner traverses its whole length and is supplied by several spring-fed and snow-fed streams as well as by its all great water reservoirs, the most important of which are the Wular, the Dal, and the Manasbal lakes.' (Hora *et al.*, 1955).

Up to now the most important treatise on the fishes of Kashmir is Heckel (1838) : FISCHE AUS CASCHMIR, which contains descriptions of sixteen species, all described as new to science. In 1844 Heckel published 'Fische Kaschmir's' in Von Huegel's KASCHMIR UND DAS REICH DER SEIK (Bd. 4, abth. 2, pp. 351-384) with a few minor changes. McClelland (1839) in the 'Supplement' to his monograph on Indian Cyprinidae commented on Heckel's species from Kashmir, which have also found mention in volumes 15 and 16 of the HISTOIRE NATURELLE DES POISSONS (Valenciennes, 1840 & 1842). Since then notable contributions concerning the ichthyofauna of Kashmir have been those by Steindachner (1866), Günther (1868), Day (1876, 1878*a*, 1878*b*), Chaudhuri (1909), Hora (1922*a*, 1922*b*, 1934, 1936, 1939), Mukerji (1936), Misra (1949), and Hora & Silas (1952 *a* and *b*). In addition, there are several references to sport-fishing in Kashmir, of which Ross (1916) and Mitchell (1918) deserve special mention.

The examination of the fresh material as well as that already present in the fish collection of the Zoological Survey of India has enabled me to codify the nomenclature of the species described by Heckel (op. cit.), as given in Table 1.

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Misra (op. cit.) has shown that Heckel's species *Schizothorax plagiostomus* and *S. sinuatus* were based on male and female specimens of the same species respectively, and as such the specific name *S. plagiostomus* (= *Oreinus plagiostomus*) which has priority is used. I have compared a few specimens from the Kashmir Valley referable to *Varicorhinus diplostomus* Heckel (= *Tylognathus valenciennesii* Heckel) with *Labeo dero* (Hamilton), which species also occurs in the Indo-Gangetic watersheds along the Himalayas and do not find sufficient difference between them to justify the Kashmir specimens being considered specifically distinct. Hence I consider them conspecific and have here used the older name, *Labeo dero*, to indicate them.

Hora (1939) gave an excellent account of the mahseer *Barbus* (*Tor*) *putitora* (Hamilton) in the ' Game Fishes of India ' series published in the *Journal*, and indicated the distribution of the species as ' all along the Himalayas '. However, one significant omission is his non-inclusion of *Labeobarbus macrolepis* Heckel in its synonymy. I take this opportunity to rectify this and at the same time support Hora's contention that infraspecific differentiation of the different species of mahseers must await detailed scrutiny of good series of material from the different watersheds along the range of distribution of the species.

Mukerji (1935) proposed a new subspecies *Crossochilus latius punjabensis* to denote the variety of *C. latius* from the Punjab and Afghanistan. I have compared specimens of this variety of *C. latius* from the Punjab with those from the Kashmir Valley referable to *Barbus diplochilus* Heckel (= *Varicorhinus barbatulus* Heckel) and find that in all diagnostic characters including the relatively smaller size at maturity as well as the smaller size of the eyes (diameter 4.2 to 5 *versus* 3.6 to 3.7 in head length in the *forma typica*) they are identical. This being the case, I propose considering the older name *diplochilus* as valid to denote the subspecies of *C. latius* occurring in the Kashmir Valley and the Punjab (Indus drainage), relegating *C. l. punjabensis* Mukerji to its synonymy.

Cobitis marmorata Heckel and *C. vittata* Heckel are at present referable to the genus *Noemacheilus* van Hasselt, while Haig (1950) has shown that *Silurus lamgur* Heckel is a synonym of *Ompok bimaculatus* (Bloch).

More than any other Indian species of fishes, I feel, that inter-specific as well as inter-generic hybridization in nature takes place to a greater extent among the Schizothoracinae. The primary factors responsible for this in the Kashmir Valley are the great abundance in numbers of each species present, overlap in breeding time, and their spatial distribution in the Valley. The collection contains specimens showing intergrading characters attributable to hybrids, the easily recognisable combinations

TABLE

No.	Heckel (1838)	Valenciennes (XV, 1840 ; XVI, 1842)	Heckel (1844)
1.	*Schizothorax plagiostomus* p. 16, pl. 1.	*Schizothorax plagiostomus* XVI, p. 213.	*Schizothorax plagiostomus*
2.	*Schizothorax sinuatus* p. 21, p. 2.	*Schizothorax sinuatus* XVI, p. 214.	*Schizothorax sinuatus*
3.	*Schizothorax curvifrons* p. 25, p. 3.	*Schizothorax curvifrons* XVI, p. 216.	*Schizothorax curvifrons*
4.	*Schizothorax longipinnis* p. 27, pl. 4.	*Schizothorax longipinnis* XVI, p. 216.	*Schizothorax longipinnis*
5.	*Schizothorax niger* p. 29, pl. 5.	*Schizothorax niger* XVI, p. 217.	*Schizothorax niger*
6.	*Schizothorax nasus* p. 32, pl. 6.	*Schizothorax nasus* XVI, p. 218.	*Schizothorax nasus*
7.	*Schizothorax hügelii* p. 36, pl. 7.	*Schizothorax hügelii* XVI, p. 219.	*Schizothorax hügelii*
8.	*Schizothorax micropogon* p. 41, pl. 8, fig. 1.	*Schizothorax micropogon* XVI, p. 220.	*Schizothorax micropogon*
9.	*Schizothorax planifrons* p. 44, pl. 8, fig. 2.	*Schizothorax planifrons* XVI, p. 224.	*Schizothorax planifrons*
10.	*Schizothorax esocinus* p. 48, pl. 9.	*Schizothorax esocinus* XVI, p. 221.	*Schizothorax esocinus*
11.	*Labeobarbus macrolepis* p. 60, pl. 10, fig. 2.	*Labeobarbus macrolepis* XVI, p. 209.	*Labeobarbus macrolepis*
12.	*Barbus diplochilus* p. 63, pl. 10, fig. 1.	*Barbus diplochilus* XVI, p. 204.	*Tylognathus barbatulus* IV, p. 376.
13.	*Varicorhinus diplostomus* p. 67, pl. 11.	*Labeo diplostomus* XVI, p. 360.	*Tylognathus valenciennesii* IV, p. 378.
14.	*Cobitis marmorata* p. 76, pl. 12, figs. 1 & 2.	..	*Cobitis marmorata* IV, p. 380.
15.	*Cobitis vittata* p. 80, pl. 12, figs. 3 & 4.	..	*Cobitis vittata* IV, p. 382.
16.	*Silurus lamgur* p. 82, pl. 12, figs. 5 & 6.	*Silurus lamgur* XV, p. ix.	*Silurus lamgur*

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Günther (V, 1864 ; VII, 1868)	Day (1878)	Present nomenclature
Oreinus plagiostomus VII, p. 160.	*Oreinus plagiostomus* p. 530.	♂ *Oreinus plagiostomus plagiostomus* (Heckel)
Oreinus sinuatus VII, p. 161.	*Oreinus sinuatus* p. 529, pl. cxxiv, fig. 4.	♀ *Oreinus plagiostomus plagiostomus* (Heckel)
Schizothorax curvifrons VII, p. 164.	(*species inquirendae*) p. 532.	*Schizothorax curvifrons curvifrons* Heckel
Schizothorax longipinnis VII, p. 166.	(*species inquirendae*) p. 532.	*Schizothorax longipinnis* Heckel
Schizothorax niger VII, p. 164.	(*species inquirendae*) p. 531.	*Schizothorax curvifrons niger* Heckel
Schizothorax nasus VII, p. 166.	(*species inquirendae*) p. 532.	*Schizothorax nasus* Heckel
Schizothorax hugelii VII, p. 164.	(*species inquirendae*) p. 532.	*Schizothorax hugelii* Heckel
Schizothorax micropogon VII, p. 163.	(*species inquirendae*) p. 532.	*Schizothorax micropogon* Heckel
Schizothorax planifrons VII, p. 163.	(*species inquirendae*) p. 532.	*Schizothorax planifrons* Heckel
Schizothorax esocinus VII, p. 166.	*Schizothorax esocinus* p. 533, pl. cxxiii, fig. 4.	*Schizothorax esocinus esocinus* Heckel
Barbus macrolepis VII, p. 131.	*Barbus tor* (Hamilton) p. 564, pl. cxxxvi, fig. 5 & pl. cxl, fig. 1.	*Tor putitora* Hamilton
Crossochilus barbatulus VII, p. 72.	*Cirrhina latia* (in part) p. 548.	*Crossochilus latius diplochilus* (Heckel)
Labeo diplostomus VII, p. 57.	*Labeo diplostomus* p. 540, pl. cxxix, fig. 2.	*Labeo dero* (Hamilton)
Nemachilus marmoratus VII, p. 356.	*Nemachilus marmoratus* p. 620, pl. clv, fig. 9	*Noemacheilus marmoratus* (Heckel)
Nemachilus marmoratus VII, p. 356.	*Nemachilus marmoratus* p. 620.	*Noemacheilus vittatus* (Heckel)
Silurichthys lamgur V, p. 36.	*Callichrous pabda* (Hamilton), p. 479, pl. cxi, figs. 2 & 3.	*Ompok bimaculatus* (Bloch)

being *Schizothorax esocinus* x *Schizothorax* sp., and *Oreinus plagiostomus* x *Schizothorax* sp.

In the fish collection of the Zoological Survey of India there is material of three species, *Schizothorax nobilis* McClelland (Z.S.I. Reg. No. 6532, and F. 5325/1), *S. intermedius* McClelland (Day's coll. Reg. No. 791) and *Lepidocephalichthys balgara* (Hamilton) (Day's coll. Reg. No. 2584), all labelled as having been obtained from ' Kashmir ' or ' Kashmir lakes '. Since the exact localities are not clearly specified and as the present collection does not indicate their occurrence in the Valley, these species are not included in the synopsis to the species known from the Valley given at the end of this paper. So also several Indian species, namely *Chela cachius* Hamilton, *Esomus danricus* (Hamilton), *Barilius vagra* Hamilton, *Barilius bendelisis* (Hamilton), *Aspidoparia morar* (Hamilton), *Puntius sophore* Hamilton, *Puntius ticto* Hamilton, *Puntius sarana* (Hamilton), *Labeo bata* (Hamilton), *Cirrhinus mrigala* (Hamilton), *Channa* sp., *Ambassis* sp., *Mastacembelus armatus* (Lacépède), etc., occurring in the Jhelum drainage below the Kashmir Valley and in the Jammu area, and species such as *Noemacheilus yarkendensis* Day, *N. ladacensis* Günther, *N. stoliczkae* (Steindachner), etc., occurring in northern Kashmir beyond the limits of the Kashmir Valley are not included in the synopsis.

The absence of any specimens of *Barbus compressus* Day in the collection also lends support to Mukerji's contention (Mukerji, 1935) that the type locality of this species is probably not Kashmir, but more likely northern Burma and that the type specimen might have been inadvertently placed in a bottle containing a specimen of *Oreinus* from Kashmir.

The two exotic or introduced species in the Valley are the American Cyprinodont *Gambusia affinis holbrookii* Girard and the Brown Trout *Salmo trutta fario* Linnaeus. The former is a recent introduction and occurs profusely in certain places thereby indicating that it is well established in the natural waters of the Valley. The Brown Trout attains very large sizes in the cool waters of the Valley and there is one on record which weighed 16 lb. 1 oz. (Mitchell 1916).

The species, both indigenous as well as exotic, at present known from the Kashmir Valley may be classified as follows:

LIST OF SPECIES

Order : SALMONIFORMES
  Family : SALMONIDAE
    Salmo trutta fario Linnaeus

Order : CYPRINODONTIFORMES
  Family : POECILIIDAE
    Gambusia affinis holbrookii Girard

Order : SILURIFORMES

Family : SISORIDAE

Glyptothorax kashmirensis Hora
Glyptosternum reticulatum McClelland

Family : SILURIDAE

Ompok bimaculatus (Bloch)

Order : CYPRINIFORMES

Family : CYPRINIDAE

Subfamily : Schizothoracinae

Oreinus plagiostomus plagiostomus (Heckel)
Ptychobarbus conirostris Steindachner
Diptychus maculatus Steindachner
Schizothorax progastus McClelland
Schizothorax nasus Heckel
Schizothorax planifrons Heckel
Schizothorax esocinus esocinus Heckel
Schizothorax hugelii Heckel
Schizothorax longipinnis Heckel
Schizothorax micropogon Heckel
Schizothorax curvifrons curvifrons Heckel
Schizothorax curvifrons niger Heckel

Subfamily : Garrinae

Crossochilus latius diplochilus (Heckel)

Subfamily : Cyprininae

Labeo dero (Hamilton)
Labeo dyocheilus (McClelland)
Tor putitora Hamilton

Family : COBITIDAE

Subfamily : Botiinae

Botia birdi Chaudhuri

Subfamily : Noemacheilinae

Noemacheilus rupicola (McClelland)
Noemacheilus gracilis Day
Noemacheilus vittatus (Heckel)
Noemacheilus kashmirensis Hora
Noemacheilus marmoratus (Heckel)
Noemacheilus yasinensis Alcock

From the above list it is clear that the bulk of the indigenous fish fauna of the Valley is composed of the Palaearctic element (of central

Asiatic origin) while those of Indian origin are *O. bimaculatus, G. kashmirensis, C.l. diplochilus, L. dero, L. dyocheilus, T. putitora, B. birdi,* and *N. rupicola.* Of the latter, *G. kashmirensis* is endemic in the Kashmir Valley, but its congeners are predominant in the Oriental Region. Six species and one subspecies of *Schizothorax* (except *S. progastus* and *S. esocinus*) and three species of the genus *Noemacheilus,* namely *N. vittatus, N. marmoratus,* and *N. kashmirensis* appear to be endemic in the Valley. On the whole, the high percentage of endemicity (about 42%) of the fish fauna of the Valley is noteworthy.

The key below embraces all valid species described by Heckel (op. cit.), those recorded by various authors from Kashmir Valley since that date, and those present in the collection under study. Specimens approximating very close to *Schizothorax progastus* McClelland and *Noemacheilus rupicola* (McClelland) are present in the collection. I find that the differences between *Schizothorax curvifrons* and *S. niger* are not sufficiently distinct to justify their treatment as separate species and hence the latter is treated here as a subspecies of *S. curvifrons.*

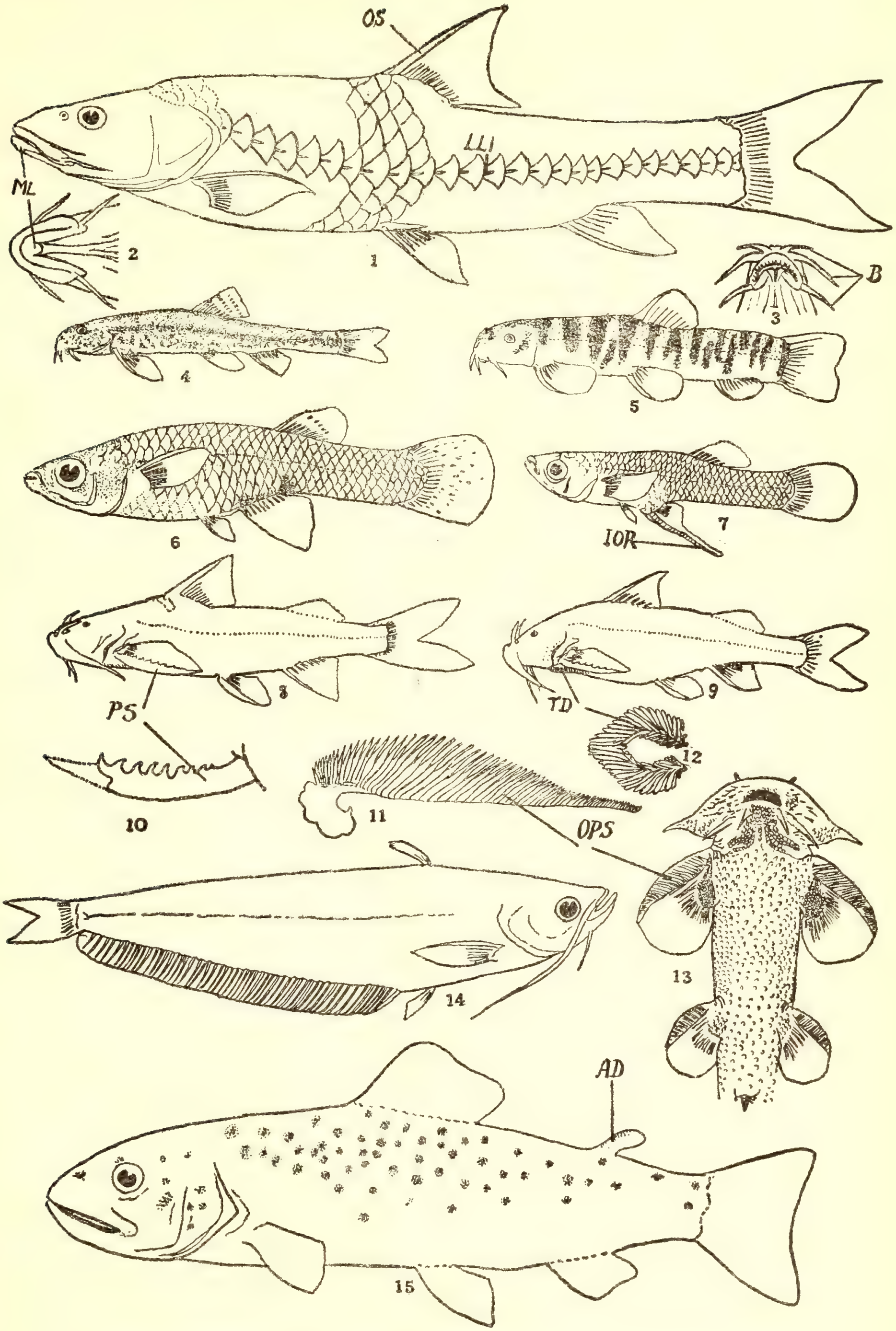
This account of the fishes of the Kashmir Valley will not be complete without a reference to the fossil fishes known from the area. Hora (1937) has described remains of Schizothoracinae (scales, one pharyngeal tooth, pectoral spine, and skeleton of caudal region) referable to *Schizothorax* or *Oreinus* [in all probability those of *S. curvifrons,* and *O. sinuatus* (= *O. plagiostoms*)] from the Karewas beds of Kashmir.

Details on the ecology of most of the species dealt with in this paper are embodied in an excellent article by G. Evelyn Hutchinson entitled ' Ecological observation on the Fishes of Kashmir and Indian Tibet ' (*Ecol. Monogr.* **9** : 145-182. 1939).

In conclusion I hope that this paper, wherein the nomenclature of Heckel's species (Heckel, op. cit.) is codified and a working ' Key ' is given for the identification of all the species known from the Kashmir Valley, will stimulate greater interest in the study of the ichthyofauna of this area. Racial studies of the Schizothoracinae, especially the important species such as *S. esocinus, S. curvifrons, O. plagiostomus,* etc., are lacking. Investigations hitherto on natural hybrids between species of the Schizothoracinae have been cursory, and detailed observations on this aspect will be of interest. It is also hoped that this account will aid in the preparation of a comprehensive work on the fishes of Kashmir.

ACKNOWLEDGEMENT

My grateful thanks are due to the late Dr. Sunder Lal Hora for placing at my disposal his collection of Kashmir fishes for study and the facilities given to me for working out the collection at the Zoological Survey of India, Calcutta. I am also thankful to Dr. S. Jones, Chief Research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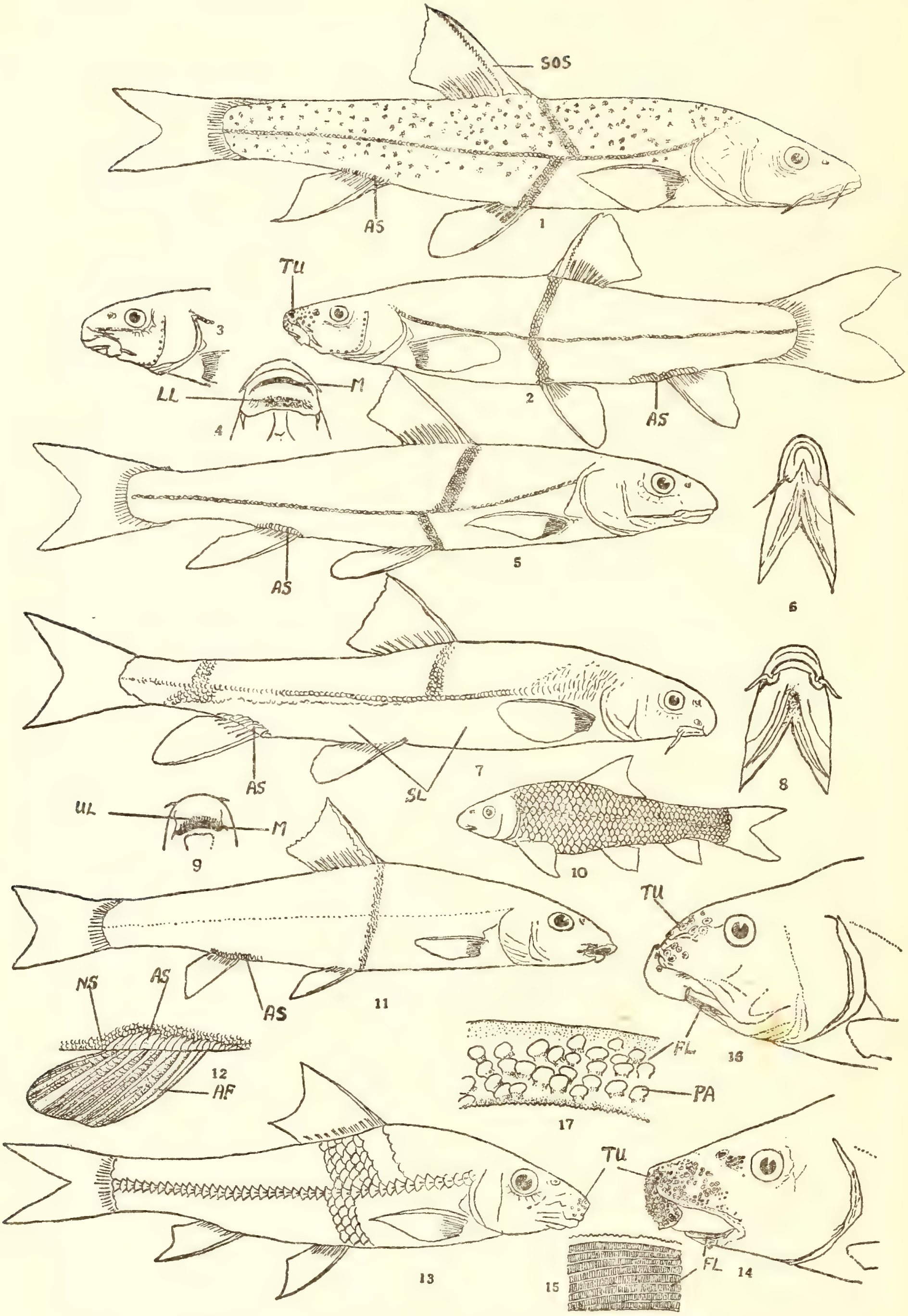
Outline drawings of Kashmir fishes showing diagnostic characters
For explanation see p. 73.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Outline drawings of Kashmir fishes showing diagnostic characters
For explanation see p. 73.

Officer, Central Marine Fisheries Research Station, for giving me facilities for working at this Station and completing this account.

Explanation to Plate I

Outline drawings of Kashmir fishes showing diagnostic characters

1. *Tor putitora* Hamilton ; 2. Ventral view of anterior part of head of same; 3. Ventral view of anterior part of head of *Noemacheilus* showing disposition of three pairs of barbels; 4. *Noemacheilus kashmirensis* Hora ; 5. *Noemacheilus rupicola* (McClelland) ; 6. *Gambusia affinis holbrookii* Girard, female ; 7. Same, Male ; 8. *Glyptothorax kashmirensis* Hora, Male ; 9. Same, Female ; 10. Pectoral spine of same ; 11. Outer pectoral spine of *Glyptosternum reticulatum* McClelland showing pinnate condition ; 12. Thoracic adhesive disc of *G. kashmirensis* ; 13. Ventral view of *G. reticulatum* ; 14. *Ompok bimaculatus* (Bloch) ; 15. The Brown Trout, *Salmo trutta fario* Linnaeus.

(Figures 1, 4, 8, 9 & 12 after Hora ; 6 & 7 after Prashad & Hora ; 14 after Day ; 11 & 13 after Hora & Silas)

Abbreviations : AD = Adipose dorsal fin ; B = three pairs of barbels ; IOR = Part of anal fin modified into intromittent organ : LLI = Lateral line; ML = Median lobe of lower lip ; OPS = Outermost pectoral spine which is soft and pinnate ; OS = Strong osseus dorsal spine ; PS = Osseus and denticulated pectoral spine ; TD = Thoracic adhesive disc.

Explanation to Plate II

Outline drawings of Kashmir fishes showing diagnostic characters

1. *Schizothorax esocinus esocinus* Heckel ; 2. *Oreinus plagiostomus plagiostomus* (Heckel), Male ; 3. Head of female of same species ; 4. Ventral view of anterior part of head of same species ; 5. *Ptychobarbus conirostris* Steindachner ; 6. Ventral view of head of same ; 7. *Diptychus maculatus* Steindachner ; 8. Ventral view of head of same ; 9. Ventral view of anterior part of head of *Crossocheilus* ; 10. *Crossocheilus latius diplochilus* (Heckel) ; 11. *Schizothorax progastus* McClelland; 12. Region of anal fin and the vent in the Schizothoracinae showing disposition of enlarged scales forming the 'Anal sheath' ; 13. *Labeo dyocheilus* (McClelland) ; 14. Head of same showing nature and disposition of tubercles ; 15. Inner fold of lower lip of same showing the transverse folds, each fold in turn being striated; 16. Head of *Labeo dero* (Hamilton) ; 17. Inner fold of lower lip of same showing papillae. (Figures 1, 5-8, 11 & 13 after Day ; 2, 3, & 10 after Misra ; 14-17 after Hora)

Abbreviations : AF = Anal fin ; AS = Anal sheath of scales ; FL = Inner fold of lower lip ; M = Mouth ; LL = Lower lip ; NS = Normal scales ; PA = Papilla ; SL = Scaleless area ; SOS = Strongly osseus and serrated dorsal spine ; TU = Tubercles ; UL = Upper lip joined to rostrum.

KEY TO THE IDENTIFICATION OF THE SPECIES

1*a*. Body totally scaleless 2

1*b*. Body partly or wholly scaled (exception being certain species of the family Cobitidae) 4

2*a*. Body laterally compressed ; barbels two pairs ; an adipose dorsal fin absent ; anal fin greatly elongate with 53 or more rays
Ompok bimaculatus (Bloch) (Pl. I, fig. 14)

2*b*. Body depressed and ventrally flattened ; barbels four pairs ; an adipose dorsal fin present ; anal fin short with not more than 6 branched rays .. 3

3*a*. A longitudinally striated thoracic adhesive disc present ; pectoral spine osseous and denticulated along its inner border
Glyptothorax kashmirensis Hora (Pl. I, figs. 8, 9, 10 & 12)

3*b*. A longitudinally striated thoracic adhesive disc absent ; pectoral spine weak and pinnate along its inner border
Glyptosternum reticulatum McClelland (Pl. I, figs. 11 & 13)

4*a*. Jaws with teeth 5

4*b*. Jaws edentulous.. 6

5*a*. Large fish with an adipose dorsal fin some distance behind rayed dorsal fin ; origin of rayed dorsal ahead of that of pelvic fin ; scales numerous with 120 or more along lateral line ; anal fin of male like that of female ; egg-layer *Salmo trutta fario* Linnaeus (Pl. I, fig. 15)

5*b*. Small minnow-like fish without an adipose dorsal fin ; origin of rayed dorsal considerably behind that of pelvic fin ; scales few, not exceeding 35 along mid-lateral line ; anal fin of male unlike that of female, modified into an intromittent organ ; live-bearer
Gambusia affinis holbrookii Girard (Pl. I, figs. 6 & 7)

6*a*. Barbels absent or when present one or two pairs only (Cyprinidae) .. 7

6*b*. Barbels three or four pairs present (Cobitidae) 22

7*a*. Vent and base of anal fin ensheathed by large imbricate or tiled scales (Schizothoracinae) 8

7*b*. Vent and base of anal fin not ensheathed by imbricate or tiled scales (Cyprininae) 19

8*a*. Margin of lower jaw with an exposed horny covering ; lower lip thick, reflected from jaw, papillated and with a free margin
Oreinus plagiostomus plagiostomus (Heckel) (Pl. II, figs. 2, 3 & 4)

8*b*. Margin of lower jaw without an exposed horny covering ; lower-lip not reflected from jaw, nor papillated, nor with a free posterior margin .. 9

9*a*. One pair of maxillary barbels ; pharyngeal teeth biserial 10

9*b*. Two pairs of barbels, one pair rostral and one pair maxillary ; pharyngeal teeth triserial 11

10*a*. Body completely covered with small scales ; origin of dorsal fin almost opposite that of pelvic fin ; pectoral fin separated from pelvic origin by about half its length
Ptychobarbus conirostris Steindachner (Pl. II, figs. 5 & 6)

10*b*. Body not completely covered with scales, they being present on upper two-thirds of body, thoracic region and sides of caudal peduncle including the scaly sheath from vent to base of anal fin ; origin of dorsal fin markedly ahead of that of pelvic fin ; pectoral fin separated from pelvic origin by a distance equal to or more than its own length

Diptychus maculatus Steindachner (Pl. II, figs. 7 & 8)

11*a*. Post-labial groove continuous

Schizothorax progastus McClelland (Pl. II, fig. 11)

11*b*. Post-labial groove interrupted in the middle 12

12*a*. Origin of dorsal fin distinctly nearer base of caudal than to tip of snout 13

12*b*. Origin of dorsal midway between or nearer to tip of snout than to base of caudal fin 15

13*a*. Snout pointed ; greatest height of body much more than five times in standard length (5.5 to 7.0) ; blackish brown spots on upper half of body, base of dorsal, caudal, and inner sides of pectoral fins ; attaining large size and weighing as much as 24 pounds

Schizothorax esocinus esocinus Heckel (Pl. II, fig. 1)

13*b*. Snout bluntly rounded ; greatest height of body five times or less in standard length ; body devoid of blackish brown spots ; moderate size, weighing not more than 7 pounds 14

14*a*. Barbels rudimentary ; diameter of eye 4.0 to 4.5 in head and 1.0 to 1.3 in snout length ; distance between origins of pelvic and anal fins contained more than four times (4.25) in standard length

Schizothorax micropogon Heckel

14*b*. Barbels well developed, atleast as long as diameter of eye ; latter 5.0 to 5.5 in head length and about 1.5 in snout length ; distance between origins of pelvic and anal fins contained less than four times (about 3.75) in standard length *Schizothorax planifrons* Heckel

15*a*. Largest scales of anal sheath as broad as or broader than diameter of eye ; scales along lateral line about 120 *Schizothorax hugelii* Heckel

15*b*. Largest scale of anal sheath small, being not more than half diameter of eye ; scales along lateral line 110 or less 16

16*a*. Length of longest anal ray contained five times or less in standard length ; diameter of eye contained less than five (4.5) in head length

Schizothorax longipinnis Heckel

16*b*. Length of longest anal ray contained six or more times in standard length ; diameter of eye contained more than five times in head length .. 17

17*a*. Dorsal fin short, its height contained 5.5 to 6.0 in standard length

Schizothorax nasus Heckel

17*b*. Dorsal fin moderately high, its height contained 4.75 to 5.0 in standard length 18

18*a*. Diameter of eye 5.0 to 5.5 in head length ; perforated scales along lateral line 98 to 102, none larger than those on adjoining rows; edge of front gill cover oblique *Schizothorax curvifrons curvifrons* Heckel

18*b*. Diameter of eye 6.0 to 7.0 in head length ; perforated scales along lateral line 91 to 95, being slightly larger and elliptical than those on adjoining rows; edge of gill cover convex *Schizothorax curvifrons niger* Heckel

19*a* Upper lip separated from rostrum by a deep groove 20

19*b*. Upper lip confluent with the skin of the rostrum
Crossocheilus latius diplochilus (Heckel) (Pl. II, figs. 9 & 10)

20*a*. Mouth terminal; scales large, about 25 to 28 along lateral line; lower lip produced into a median lobe and post-labial groove continuous; last undivided dorsal ray strongly ossified
Tor putitora Hamilton (Pl. I, figs. 1 & 2)

20*b*. Mouth inferior; scales smaller, about 41 to 45 along lateral line; lower lip not produced into a median lobe and post-labial groove interrupted in the middle; last undivided dorsal ray not strongly ossified 21

21*a*. Dorsal with 9 or 10 branched rays; inner surface of lower lip closely papillated *Labeo dero* (Hamilton) (Pl. II, figs. 16 & 17)

21*b*. Dorsal with 11 branched rays; inner surface of lower lip striated with transverse folds *Labeo dyocheilus* (McClelland) (Pl. II, figs. 13, 14 & 15)

22*a*. Barbels four pairs; body greatly compressed and deep; bifid backwardly directed suborbital bony spine present in both sexes
Botia birdi Chaudhuri

22*b*. Barbels three pairs; body subcylindrical; bifid backwardly directed suborbital spine absent 23

23*a*. Body with distinct dark vertical bands descending from back to ventral side and alternating with lighter bands
Noemacheilus rupicola (McClelland) (Pl. I, fig. 5)

23*b*. Body without dark vertical bands and alternating lighter bands .. 24

24*a*. Pelvic fins fall short of vent by considerable distance
Noemacheilus gracilis Day

24*b*. Pelvic fins reaching or surpassing vent 25

25*a*. Origin of dorsal fin midway between base of caudal and tip of snout .. 26

25*b*. Origin of dorsal nearer to base of caudal than to tip of snout .. 28

26*a*. Lateral line incomplete consisting of only a few pores and not extending beyond vertical from free end of pectoral fin
Noemacheilus vittatus (Heckel)

26*b*. Lateral line complete or clearly defined up to vertical opposite posterior end of anal base, being indistinct on the caudal peduncle (exception being female *N. yasinensis* in which L.l. is clear only up to above pelvic fin) .. 27

27*a*. Pectoral as long as or slightly longer than head; least height of caudal peduncle about as broad as diameter of eye in specimens over 55 mm. in standard length *Noemacheilus yasinensis* Alcock (Male)

27*b*. Pectorals shorter than head length; least height of caudal peduncle considerably greater than diameter of eye in specimens over 55 mm. in standard length *Noemacheilus kashmirensis* Hora (Pl. I, fig. 4)

28*a*. Snout and post orbital part of head of equal length; anal fin separated from caudal by a distance almost equal to its own length
Noemacheilus marmoratus (Heckel)

28*b*. Snout shorter than post-orbital part of head; anal fin separated from caudal fin by a distance considerably lesser than its own length
Noemacheilus yasinensis Alcock (Female)

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The Diatom Flora of the Bombay and Salsette Islands

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(*With* 120 *figures*)

INTRODUCTION

This account deals with the diatom genera, *Pinnularia*, *Amphiprora*, *Amphora*, *Cymbella*, and *Gomphonema*, collected from the year 1945-1949 onwards up to 1958 in the form of stray samples. It continues the chain of first three papers jointly published by Mrs. E. A. Gonzalves and myself (1952-54).

Since 1954 the author's work on the diatom flora of the Bombay and Salsette Islands has been disturbed by difficulties and circumstances beyond his control. However, during this long period several other collections were made at different times from the same and other localities of the said region and were examined at different institutions on account of the frequent transfers that the author suffered. With the further observations some more diatoms were recorded, making this paper more comprehensive. In this paper the distribution of individual diatoms in the area is also indicated. Several illustrations are given of certain species to suggest the form-change or variation exhibited by them.

Further, the arrangement of diatoms is mostly done according to Cleve-Euler's (1951-55) monograph in consultation with that of Hustedt (1930) and several other publications. The diatoms already recorded in the Indian literature are merely listed here with some necessary notes or remarks ; the rest are fully described and illustrated. Of diatoms that are considered to be new taxa, besides their Latin diagnoses, the slide numbers are given in accordance with the International Code of Botanical Nomenclature, Art. 35, 1956. All the material relating to this paper is with the author in his own herbarium.

Again, to validate the new taxa published by the author in his earlier paper on ' Freshwater Diatoms from Kolhapur and its immediate

Environs,' *J. Bombay nat. Hist. Soc.* 55 (3) : 493-511, 1958, the following slide numbers refer to those specific taxa, thus :

Navicula cuspidata Kütz. f. *brevirostrata* f. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 18-9-1954, et positus in herbario proprio auctoris sub numero KOP-49, (slide).

Pinnularia kolhapurensis sp. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-61, (slide).

Gomphonema lacus-rankala sp. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-63, (slide).

Gomphonema lacus-rankala v. *robusta* v. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-64, (slide).

Gomphonema lacus-rankala v. *gracilis* v. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-65, (slide).

Gomphonema spicula sp. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 18-9-1954, et positus in herbario proprio auctoris sub numero KOP-68, (slide).

Genus **PINNULARIA** Ehrenberg 1840

Section TENUISTRIATAE Å. Berg.

1. **Pinnularia appendiculata** (Ag.) Cl. (Fig. 1)

Schmidt, A., 1874-1944, Atlas Diat. t. 313, f. 10-11 ; Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 565, t. 20, f. 13 ; 1930, Bacil. 317, f. 570a ; Skvortzow, B. W., 1938, *Philipp. J. Sci.* 66 : 169, pl. 2, f. 8 ; Tiffany & Britton, 1952, Alg. Illinois 258, pl. 69, f. 796 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 18, f. 1004 a-d (=v. *genuina* A. Cl.).

Valves 44-56.5 μ long and 6-8.5 μ broad, linear-lanceolate with weakly constricted, produced subcuneate ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures slightly curved. Axial area quite narrow, linear-lanceolate ; central area large, rhomboid, reaching the sides. Striae 12-14 in 10 μ, radial in the middle and convergent at the ends.

This species agrees well with the type described by Hustedt and others, in the outline, apices, central and axial areas and the nature of the striae. The range of dimensions recorded here closely agree with those indicated by Cleve-Euler, but appear to be larger than those given by Hustedt, Tiffany & Britton, and Skvortzow. The number of striae per 10 μ are less here than recorded by Hustedt and Tiffany & Britton but agree with those recorded by Cleve-Euler and Skvortzow. It appears that the number of striae per 10 μ suffer reduction in larger forms as may be seen from the following table :

Author	Length	Breadth	Striae per 10 μ
Hustedt	18-36μ	4-6μ	16-18
Skvortzow	35μ	5μ	12-13
Tiffany & Britton ..	18-36μ	4-6μ	16-18
Cleve-Euler	35-58μ	5-7μ	(12) 13-16
Local forms	44-56.5μ	6-8.5μ	12-14

Again, Berg describes a similar looking form as *P. subcapitata* Greg. (Berg, *Arkiv Bot.* 1945, 32 A(1) : 17, t. 5, f. 176) and Skvortzow as *P. gibba* Ehr. (Skvortzow, 1937, *Philipp. J. Sci.* 61 : 278, pl. 5, f. 2), but I am not inclined to refer the present specimens to either *P. subcapitata* or *P. gibba*, which are obviously different species. In fact, Berg's *P. subcapitata* and Skvortzow's *P. gibba*, appear closer to *P. appendiculata* if Cleve-Euler's record is considered, as given in the above table. In any way I consider the present specimens to be *P. appendiculata* in light of the data given above.

Habitat : Fresh water. Collected from Jogeshwari, Goregaon, Andheri, and Dahisar ponds and pools, usually in a small number.

2. **Pinnularia molaris** Grun. (Fig. 2)

Schmidt, 1874-1944, Atlas Diat. t. 313, f. 18 ; Hustedt, 1924, *Naturw. Unters. Sarek.* t. 20, f. 8 ; 1930, Bacil. 316, f. 568 ; Skvortzow, B. W., 1937, *Philipp. J. Sci.* 62 : 337, pl. 11, f. 9 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 18, 1005.

Valves 28-33 μ long and 5.6-6.2 μ broad, linear-lanceolate with subcuneate rounded ends. Raphe thin and straight with curved terminal fissures. Axial area quite narrow ; central area large, rhomboid, reaching the sides. Striae 14-18 in 10 μ, fine, radial in the middle and convergent at the ends.

Habitat : Fresh water. Pools and streams at Borivli and Kanheri caves and certain ponds at Andheri, Vile-Parle, Dahisar, and other places. Usually collected as a stray form.

Section SUBVIRIDES A. Cl.

3. **Pinnularia finlandica** A. Cl. (Fig. 3)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 22, f. 1027.

Valves 50-57.5 μ long and 10-11.2 μ broad, linear with parallel sides and rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide about 1/4 the width of the valve, linear ; central area slightly dilated and somewhat unilateral. Striae 10-11 in 10 μ, coarse, slightly radial in the middle and convergent towards the ends.

Habitat : Fresh water. Collected from ponds at Andheri and Goregaon, and some pools at Jogeshwari and other places. Not common.

This species agrees well with the type except that it has slightly larger dimensions.

Section NODOSAE A. Cl.

4. **Pinnularia braunii** (Grun.) Cl. (Fig. 4)

Hustedt, 1930, Bacil. 319, f. 577 ; Cleve-Euler, A., 1951-55, Diat. Schwed Finn.—IV, 24, f. 1020 a-c (=v. *genuina* A. Cl. et etiam v. *marginata* A. Cl.) ; Schmidt, A. 1874-1944, Atlas Diat. t. 45, f. 77-78 (= *Navicula brauniana* Grun.) ; Van Heurck, 1896, Treat. Diat. 173, pl. 2, f. 95 (= *Nav. braunii* Grun.).

Valves 43-50 μ long and 8.5-9.5 μ broad, broadly lanceolate with constricted, produced capitate ends. Raphe thin and straight with central pores closely set and unilaterally bent and terminal fissures curved. Axial area very wide, lanceolate ; central area very wide, rhomboid, reaching the sides. Striae 10-12 in 10 μ, very coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from several pools, ponds and tanks in the area, usually in a small number or as a stray form.

5. **Pinnularia polyonca** (Bréb.) O. Müll. (Fig. 5)

Hustedt, 1930, Bacil. 319, f. 576 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 24, f. 1021 ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 54-55 (= *Navicula mesotyla* (Pinn.) Ehr.) ; Van Heurck, 1896, Treat. Diat. 174, pl. 2, f. 99 (=*Nav. polyonca* Bréb.).

Valves 90-100 μ long and 14-15.2 μ broad, lanceolate with strongly triundulate sides and strongly capitate-cuneate ends. Raphe thin and straight with closely set central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, sublanceolate ; central area large reaching the sides. Striae 8-10-12 in 10 μ, coarse, radial in the middle and strongly convergent at the ends and closer.

Habitat : Fresh water. Collected from pond at Andheri usually as a stray form. Rare in the area.

Cleve-Euler refers *Nav. mesotyla* of Schmidt's ' Atlas ' to *P. polyonca* but *N. mesotyla* has rounded ends and therefore differs from *P. polyonca* in this respect.

6. **Pinnularia acrosphaeria** (Bréb.) W. Sm.

Habitat : Fresh water as well as somewhat brackish water. Widely distributed in the area, mostly in marginal slime of pools, ponds, and tanks. It was noted to be gregarious in ponds at Andheri and Goregaon.

7. **Pinnularia acrosphaeria** f. **undulata** Cl.

Habitat : Fresh water. Sometimes collected along with the species. Not common in the locality.

8. **Pinnularia acrosphaeria** v. **minor** Cl. (Figs. 6-7)

Habitat : Fresh water as well as in somewhat brackish water. Widely distributed in the area, but always recorded in a small number.

9. **Pinnularia acrosphaeria** v. **sandvicensis** A. S. (Figs. 8-9)

Schmidt, A., 1874-1944, Atlas Diat. t. 43, f. 14-15, 18 ?

Valves 70-85 μ long and 12.5-13 μ broad, linear, strongly inflated in the middle, ends broadly swollen and rounded. Raphe thin and straight with central pores closely set and unilaterally bent and terminal fissures curved. Axial area very wide, about 1/3 the width of the valve, linear with fine scattered markings or puncta ; central area slightly formed. Striae 9-10 in 10 μ coarse, weakly radial in the middle, at length perpendicular to the middle line and weakly convergent at the ends.

Habitat : Fresh water. Streams at Borivli and Powai lake. Rare.

This diatom is distinguished on account of the strong inflations in the middle and at the ends.

10. **Pinnularia dolosa** sp. nov. (Figs. 10-11)

Schmidt, A., 1874-1944, Atlas Diat. t. 43, f. 17 (=nomen nudum).

Valvae 60-90 μ longae atque 13-15 μ latae, lineares, tumidae in medio; apicibus vix dilatatis ac late rotundatis. Raphe evoluta in zona hyalina, ornata poris centralibus proxime positis et unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis amplissima, circiter 1/3-1/2 latitudinis valvae, linearis et irregulariter subtiliter punctata ; area centralis paulum unilateraliter dilatata. Striae 9-11 in 10 μ, crassae, paululum radiales in medio, tandem perpendiculares ad lineam mediam ac paulum convergentes ad apices. Typus lectus a H. P. Gandhi ad Andheri die 1945-48, et positus in herbario proprio auctoris sub numero BOM-AND.—43-45.

Valves 60-90 μ long and 13-15 μ broad, linear, tumid in the middle ; ends scarcely dilated and broadly rounded. Raphe formed in the hyaline zone with central pores closely set and unilaterally bent and terminal fissures curved. Axial area very wide about 1/3-1/2 the width of the valve, linear with fine irregularly disposed puncta ; central area slightly unilaterally dilated. Striae 9-11 in 10 μ, thick, weakly radial in the middle, at length perpendicular to the middle line and at the ends convergent.

Habitat : Fresh water. Collected as a common form in a pond at Andheri. Seen as a constant form for a period of almost three years.

An illustration occurs in Schmidt's ATLAS DIAT., without name, but it has been remarked that it is somewhere intermediate between *Navicula* (*Pinnularia*—Ehr. ?) *macilenta* and *Navicula* (*Pinn.*) *acrosphaeria* Bréb., ' ATLAS DIAT. ', t. 43, f. 9 and 16 respectively. From my continued observation of this species, I find it to be related to *P. acrosphaeria* (Bréb.) W. Sm. However, it differs from *P. acrosphaeria* in having non-dilated apices, clear hyaline zone around the raphe, much wider axial area, and the puncta in the axial area being much finer. It is therefore considered to be a new species and placed near *P. acrosphaeria*, being related to it.

11. **Pinnularia dolosa** v. **chariessa** v. nov. (Fig. 12)

Valvae 117-120 μ longae atque 16-17 μ latae, sublanceolatae, tumidae in medio ac apicibus rotundatae. Raphe, zona hyalina, atque area axialis ut in typo. Area centralis ampla, ad latera perveniens. Striae 8-9 in 10 μ, crassae, paulum radiales in medio, tandem perpendiculares ad lineam mediam ac paulum convergentes ad apices, ut in typo. Typus lectus a H. P. Gandhi ad Andheri die 1946-48, et positus in herbario proprio auctoris sub numero BOM-AND.—47.

Valves 117-120 μ long and 16-17 μ broad, sublanceolate, tumid in the middle with rounded ends. Raphe, hyaline zone, and the axial area as in the type. Central area large and extended to the sides. Striae 8-9 in 10 μ, thick, weakly radial in the middle and at the ends slightly convergent as in the type.

Habitat : Fresh water. Collected from a pond at Andheri along with the type but in a smaller number or as a stray form.

This diatom differs from the above type in being gracefully lanceolate. Moreover, the central area is extended to the sides and the striae are more widely set ; therefore they count less in number than in the type.

Section DISTANTES Cleve

12. **Pinnularia ueno** Skvortzow v. **wadalensis** v. nov. (Figs. 13-14)

Valvae 32-47.5 μ longae atque 10-11.7 μ latae, lineares, marginibus parallelis vel paululum concavis, apicibus cuneatis, late rotundato-truncatis. Raphe crassa, poris centralibus unilateraliter inclinatis ac fissuris terminalibus aliquantum curvatis. Area axialis modica, lineari-lanceolata ; area centralis ampla, rhomboidea ad latera pertingens. Striae 6.5-8 in 10 μ, crassae, radiales in medio ac paulum convergentes in utroque apice. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—5-7.

Valves 32-47.5 μ long and 10-11.7 μ broad, linear with parallel or weakly concave sides and cuneate, broadly truncate-rounded ends. Raphe thick with central pores unilaterally bent and terminal fissures slightly curved. Axial area moderate, linear-lanceolate ; central area large, rhomboid, reaching the sides. Striae 6.5-8 in 10 μ, thick, radial in the middle and slightly convergent at the ends.

Habitat : Fresh water. Collected from pools and ponds at Wadala as a frequent form during post-monsoon seasons. Some stray specimens also were recorded from Powai lake.

This diatom agrees very closely with *P. ueno* Skv. (Skvortzow, 1937, *Philipp. J. Sci.* 61 : 44, pl. 7, f. 1), in the outline, arrangement of striae, and other details. However, of the specimens collected here the dimensions are much smaller. Moreover, the striae are fewer in number than in *P. ueno,* hence it differs. Again, Foged has described a similar looking form as *P. microstauron* (Ehr.) Cl. (Foged, N., 1955, *Medd. om Gronland* 127 : 59, pl. 11, f. 21), which is in fact very different from *P. microstauron* (Ehr.) Cl. I am not sure if it could be the same. However, I am inclined to consider it with the present diatom, since it bears great likeness. Further, I place the present diatom under ' Distantes ' group on account of the robust and distantly set striae.

Section BREVISTRIATAE Cleve em.

13. **Pinnularia brevicostata** Cl. v. **indica** v. nov. (Fig. 15)

Valvae 90-95 μ longae atque 19.8-20.5 μ latae, lineari-ellipticae ac apicibus rotundatis. Raphe tenuis vel crassa, ornata poris centralibus distinctis, unilateraliter inclinata ac fissuris terminalibus paulum curvatis. Area axialis amplissima, circiter 1/3-1/2 latitudinis valvae, sublanceolata ; area centralis obscura. Striae 5.5-6 in 10 μ, crassissimae, aliquantum radiales in medio atque in utroque apice convergentes. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—18.

Valves 90-95 μ long and 19.8-20.5 μ broad, linear-elliptical with rounded ends. Raphe thin or thick with central pores distinct and unilaterally bent and terminal fissures slightly curved. Axial area very wide, about 1/3-1/2 the width of the valve, sublanceolate; central area not obvious. Striae 5.5-6 in 10 μ very coarse, slightly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams and Powai lake as a stray form.

This diatom in its general features agrees well with *P. brevicostata* Cl. (Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 37, f. 1045 a-b) (= v. *genuina* A. Cl.) and its other varieties. However, the present specimens differ from the type in having more uniformly convex sides, somewhat smaller size, and coarser and therefore fewer striae. It is, therefore, tentatively regarded as a new variety.

14. **Pinnularia meisteri** A. Cl. v. **scandica** A. Cl. (Fig. 16)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 40, f. 1050 b.

Valves 61-68 μ long and 11-13 μ broad, broadly linear, slightly swollen in the middle with somewhat inflated rounded ends. Raphe thin and straight with terminal fissures curved. Axial area narrow, linear ; central area only slightly dilated. Striae about 12 in 10 μ, coarse, slightly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from some pools and ponds at Wadala, Goregaon, Vile-Parle, and streams at Borivli. Not common.

Section LUNULAE A. Cl.

15. **Pinnularia stomatophora** Grun. v. **triundulata** Font. (Fig. 17)

Hustedt, 1942, *Int. Rev. Hydrobiol Hydrogr.* 42 (1/3) : 88, f. 168-170; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 41, f. 1053 d (= *P. stomatophoroides* Mayer f. *triundulata* (Font.) A. Cl.).

Valves 115-118.8 μ long and 13.7-14 μ broad, sublinear, with triundulate sides and produced capitate rounded ends. Raphe slightly thick and straight with bayonet-shaped terminal fissures. Axial area somewhat narrow, linear ; central area without lunulae, large, rhomboid, reaching the sides. Striae 10-12 in 10 μ, coarse, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Tansa lakes, mostly as a stray form.

Some specimens of this diatom found in the collections, none showed lunulae in the central area, which are supposed to be the characteristic feature of the type. However, Hustedt illustrated a form (fig. 169) without lunulate markings and in the remarks stated that a good deal of variation seemed to occur in the species. Cleve-Euler has treated the same as *P. stomatophoroides* Mayer f. *triundulata* (Font.) A. Cl., without assigning any reasons as I believe. I do not favour Cleve-Euler's diagnosis, since *P. stomatophoroides* was established in 1940, much later than *P. stomatophora* Grun. v. *triundulata* Font. 1917.

Further, the present diatom also agrees with *P. gibba* f. *subundulata* Mayer (Hustedt, 1930, Bacil. 327, f. 601) in the outline, central and axial areas, and the number of striae. However, I separate the same on the basis of thicker raphe and bayonet-shaped terminal fissures taking them as characteristic features of *P. stomatophora.* A more or less similar diatom has been described by Skvortzow as *P. platycephala* (Ehr.) Cl. v. *hattoriana* Skv. (Skvortzow, 1935, *Philipp. J. Sci.* 57 : 470, pl. 2, f. 4 ; 1937, *ibid.* 61 : 41, pl. 6, f. 2), having bayonet-shaped terminal fissures and triundulate sides. However, this diatom has not been well understood, since Skvortzow illustrated the type somewhat differently in the papers hitherto cited. Moreover, *P. platycephala* has terminal fissures bent in opposite directions, and this feature being of diagnostic importance for the type finds no appearance in the variety v. *hottoriana* Skv.

Section PARALLELAE A. Cl.

16. **Pinnularia episcopalis** Cleve (Fig. 18)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 569, t. 21, f. 1 ; 1930, Bacil. 323, f. 592 ; Mills, F., 1932, *J. roy. microsc. Soc.* 52 : 389, pl. 3, f. 30 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 47, f. 1063 c (= v. *elliptica* A. Cl.).

Valves 108-112 μ long and 24.6-25 μ broad, subelliptical with rounded ends. Raphe thin, slightly bent with central pores large, somewhat hook-like and terminal fissures oblique and slightly curved. Axial area linear ; central area somewhat quadrate, reaching the sides. Striae 8-9 in 10 μ, thick, closely set, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Tansa lakes in a smaller number. Stray specimens also were collected from some hill-streams at Borivli.

17. **Pinnularia platycephala** (Ehr.) Cl. (Fig. 19)

Schmidt, A., 1874-1944, Atlas Diat. t. 310, f. 6-8 ; Hustedt, 1930, Bacil. 324, f. 593 ; Berg, 1945, *Ark. Bot.* 32 A (1) : 15, t. 4, f. 155 ; Cleve-Euler, A. 1951-55, Diat. Schwed. Finn.—IV, 47, f. 1065 a-b. (= v. *genuina* A.Cl.).

Valves 81-95 μ long and 16.5-17.5 μ broad, linear or sublinear, sides distinctly triundulate, ends broadly capitate-rounded (two ends somewhat differ in appearance). Raphe thin, not quite straight, with large central pores and terminal fissures thick, sharply curved in the opposite directions. Axial area somewhat narrow, linear; central area quadrate, somewhat narrow while reaching the sides. Striae 9-11 in 10 μ, coarse, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from ponds at Andheri, Dahisar, and Goregaon, streams at Borivli, and Powai lake. It occurred in a small number. Not common.

Section DIVERGENTES Cleve em.

18. **Pinnularia legumen** Ehr. v. **florentina** (Grun.) Cl.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Tansa lakes, usually in a small number.

19. **Pinnularia scythica** (Pant.) Gandhi, comb. nov. (Fig. 20)

Navicula scythica Pantocsek, Beitr. Kenn. foss. Bacl.—III, 81, t. 23, f. 335, 1905 ; Schmidt, A., 1874-1944, Atlas-Diat. t. 45, f. 30 ? (= *P. decurrens* Ehr.) ; t. 391, f. 9-10 (= *P. krasskei* Hust. v. *ventricosa* Hust.).

Valves 87.4-92 μ long and 16.6 μ broad, linear-lanceolate with uniformly convex sides and constricted, broadly produced rounded ends. Raphe thin or somewhat thick with central pores distinct and terminal fissures curved. Axial area about 1/5-1/4 the width of the valve, sublinear ; central area large and more or less elliptical. Striae 9-10 in 10 μ, thick, closely set, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Tansa lakes in good number, and some stray specimens were recorded from a tank at Bandra and some other larger ponds. Not quite common.

This agrees well with Pantocsek's *Nav. scythica* Pant., which from the illustration evidently appears to be *Pinnularia* on account of the smooth costae. Here, therefore, Pantocsek's *Nav. scythica* is emended. From further survey of the literature, *P. decurrens* Ehr. (Schmidt's ' Atlas ' t. 45, f. 30) more or less compares here, except that it has more evident lanceolate shape and less apparently constricted produced ends. Again, in the ' Atlas ' *P. krasskei* Hust. v. *ventricosa* Hust. (t. 391, f. 9-10) is illustrated, which very closely agrees with the present specimens as well as with Pantocsek's *Nav. scythica* in the outline, apices, central and axial areas, and the number and arrangement of the striae. I, therefore, consider *P. krasskei* v. *ventricosa* Hust. identical with *Nav. scythica* Pant., the latter needing emendment of its generic name, which I herewith effect.

20. **Pinnularia divergens** W. Sm. (Fig. 21)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 568, t. 22, f. 4 ; 1930, Bacil. 323, f. 589 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 51, f. 1071 a (= v. *minor* A. S.) ; Schmidt, A., 1874-1944, Atlas Diat. t. 44, f. 42, (= *Nav. divergens* (Pinn.) W. Sm. f. *minor*. A. S.).

Valves 80-87.5 μ long and 14.4-15 μ broad, linear-lanceolate with constricted, broadly produced, rounded ends. Raphe thin and somewhat undulate with central pores unilaterally bent and terminal fissures thick and more or less bayonet-shaped. Axial area linear ; central area large, rhomboid, reaching the sides with conical projections formed on the sides. Striae 9-11 in 10 μ, thick, congested, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams, Powai and Tansa lakes, as a less frequent form. It was usually found in brownish masses of decaying vegetable matter lying on the margins.

21. **Pinnularia divergens** v. **undulata** Hèr. & Perag. (Fig. 22)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (5) : 568, t. 22, f. 5 ; 1930, Bacil. 323, f. 591 ; Skvortzow, B. W., 1938, *Philipp. J. Sci.* 66 : 171, pl. 1, f. 28 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 52, f. 1071 d.

Valves 68-75 μ long and 13-13.5 μ broad, linear-lanceolate with distinctly triundulate sides and constricted, broadly produced rounded ends. Striae 10 in 10 μ. In all other features alike the above type.

Habitat : Fresh water. Collected from Powai and Tansa lakes and ponds at Andheri, Goregaon, and Vile-Parle. Not quite common.

22. **Pinnularia divergens** v. **elliptica** Grun. (Fig. 23)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : t. 21, f. 1 ; 1930, Bacil. 323, f. 590 ; Mills, F. W., 1932, *J. roy. microsc. Soc.* 52, 389, pl. 1, f. 14 ; Clever-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 52, f. 1071 e.

Valves 68-90 μ long and 15-18 μ broad, linear-elliptical with rounded ends. Striae 8-10 in 10 μ. In all other details like the type described above.

Habitat : Fresh water. Collected as a common form from Andheri and Goregaon ponds. Stray specimens were also collected from some larger pools and streams at Borivli.

23. **Pinnularia divergens** v. **capitata** Mills (Fig. 24)

Mills, F. W., 1932, *J. roy. microsc. Soc.* 52 : 389, pl. 2, f. 15.

Valves 65-81 μ long and 12.8-14 μ broad, linear-lanceolate with weakly triundulate sides and constricted, broadly capitate rounded ends. Axial area somewhat narrow, linear. Striae 10-12 in 10 μ. In all other details like the type described above.

Habitat : Fresh water. Collected from Powai, Vihar, and Tansa lakes, inhabiting decaying mass of vegetable matter. Fairly common. Isolated specimens also were recorded from a pond at Andheri.

This diatom agrees well with the specimen described by Mills, except that the breadth here is much less. From the measurement of the illustration given by Mills it appears that some mistake has crept in, since the breadth given in the text is 0.025 mm. whereas by measurement it comes out to be 0.01566 mm. With the measured dimensions, therefore, my specimens agree more or less quite well with those of Mills ; so I treat my specimens. Moreover, some smaller specimens also have been recorded from the present region.

Again, a reference is cited by Mills, which refers to Schmidt's ' Atlas' t. 44, f. 12 (an illustration without name), to be *P. divergens* v. *capitata.* I think this to be different, since Mills's illustration clearly shows triundulate sides whereas in the ' Atlas ' that is not the case.

Further, Cleve-Euler described a diatom under a similar name, i.e. *P. divergens* v. *capitata* n. v. (Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 53, f. 1071 k), which befits *P. divergens* characteristics, but greatly differs from Mills's and present specimens. According to the International Code of Botanical Nomenclature, one name for two different specimens cannot hold good and at the same time rule of priority has to be observed. Under the circumstances, therefore, Cleve-Euler's specimen needs a new name.

24. **Pinnularia brébissonii** (Kütz.) Cl. (Fig. 25)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 53, f. 1071a (= v. *genuina* O. Müll.) ; Schmidt, A., 1874-1944, Atlas Diat. t. 44, f. 17-19 (= *Navicula brébissonii* Kütz.) ; Van Heurck, 1896, Treat. Diat. 171, pl. 2, f. 82 (= *Nav. brébissonii* Kütz.) ; Pantocsek, J., 1905, *Beitr. z. Kenn. foss. Bacil.* III, 65, t. 19, f. 279 (= *Nav. brebissonii* v. *fossilis* Pant.) ; Hustedt, 1930, Bacil. 321, f. 584 (= *P. microstauron* (Ehr.) Cl. v. *brébissonii* (Kütz.) Hust. ; Foged, N., 1949, *Dansk Bot. Ark.* 13 (6) : 30, II, f. 11 (= *P. microstauron* v. *brébissonii*) ; Jurilj, A., 1954, *Jugoslav Akad. Znan. Umjet.* 1954 : 141, f. 44 a-b (=*P. microstauron* v. *brébissonii*).

Valves 60 μ long and 14.8 μ broad, linear-elliptical to subelliptical with subcuneate rounded ends. Raphe thin and straight with unilaterally bent central pores and slightly curved terminal fissures. Axial area fairly wide, linear-lanceolate ; central area large, rhomboid, reaching the sides. Striae 10-11 in 10 μ, coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from ponds at Andheri and Goregaon, usually in a small number. Stray specimens were also observed in some of the samples from Powai lake.

The present species conforms well with illustrations given in the ' Atlas ' and by Pantocsek, Van Heurck, Foged, and Jurilj. However, Foged and Jurilj show somewhat narrower axial area. Hustedt's illustration differs much more than in the works hitherto cited in as much as that it has more linear outlines and somewhat distinctly cuneate ends. It is possible to keep Hustedt's specimen apart to be treated as variety of the present species, which is being done by Cleve-Euler (v. *acuta* A. Cl.)

25. **Pinnularia brébissonii** v. **producta** A. Cl. (Fig. 26)

Some larger specimens were recorded from the area than those found from paddy and millet fields at Mugad. Moreover, the present specimens have comparatively a fewer striae (dimensions 53-63 × 12-14 μ, str. 8.5-10 in 10 μ).

Habitat : Fresh water. Collected from several ponds, large pools and tanks in the area. More frequently noted in a pond at Goregaon.

26. **Pinnularia brébissonii** v. **producta** f. **biundulata** (O. Müll.) A. Cl. (Fig. 27)

The specimens recorded from the area are comparatively smaller than those recorded from Mugad area (dimensions recorded here: 29-40 × 6.2-8 μ, str. 10-12 in 10 μ).

Habitat : Fresh water. Collected from lakes, ponds, and tanks in the area. Fairly distributed.

27. **Pinnularia balatonis** (Pant.) Gandhi, comb. nov. (Fig. 34)

Navicula balatonis Pantocsek, *Res. Wiss. Erf. Balat.* 2 (2) : 33, t. 3, f. 64, 1902 ; Skvortzow, B. W., 1928-32, *Ceylon J. Sci.* 11 : 256, pl. 33, f. 4 (= *P. microstauron β brébissonii* (Kütz.) May. v. *ceylonica* Skv.) ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 55, f. 1072 t. (= *P. brébissonii* v. *acuta* A. Cl.).

Valves 46-51.3 μ long and 10-12 μ broad (in the middle 8-9 μ), linear with concave sides and subcuneate rounded ends. Raphe thin and more or less straight, terminal fissures curved. Axial area narrow, sublinear ; central area large, rhomboid, reaching the sides. Striae 9-10 in 10 μ, coarse, radial in the middle and convergent at the ends, middle striae gradually abbreviated.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Not common.

This species agrees very closely with Pantocsek's *Nav. balatonis* Pant., which is in fact a *Pinnularia* type as suggested by the illustration. Cleve-Euler also probably considers it to be a *Pinnularia* as suggested by the remark : ' a plumper form than that of Hustedt's *P. microstauron* v. *brébissonii* (Kütz.) Hust.' I, therefore, merit the remarks of Cleve-Euler and effect the emendment by recognising *Nav. balatonis* as *Pinnularia balatonis*.

Further, I consider *P. balatonis* (Pant.) Gandhi to be a distinct species, since I never found it in association of *P. brébissonii* (Kütz.) Cl. Moreover, its outline and the arrangement of striae appear to be different from *P. brébissonii*, which can be appreciated only on close comparison. However, it may be remarked that it has a close affinity with *P. brébissonii*, Again from the literature it appears that Skvortzow described a form from Ceylon which is almost identical with the present one, except that it has slightly smaller range of dimensions (dimensions : 40-43 × 8.5 μ, str. 12 in 10 μ). Likewise Cleve-Euler's *P. brébissonii* v. *acuta* 'fig. 1072 t' agrees well here (dimensions : 37-43 × 8-10 μ. str. 13 in 10 μ). Giving little importance to these size differences, I herewith propose to refer Skvortzow's *P. microstauron β brébissonii* v. *ceylonica* Skv. and Cleve-Euler's *P. brébissonii* v. *acuta* 'fig. 1072 t only' to *P. balatonis* (Pant.) Gandhi, having range of dimensions : 37-51.3 × 8-13 μ, striae 9-13 in 10 μ.

28. **Pinnularia microstauron** (Ehr.) Cl. (Figs. 28-29)

Habitat: Fresh water. Collected from various small and large bodies of water in the region. It was usually found in rotting masses of vegetable matter spread on the edges of pools. Common but never found to be gregarious.

29. **Pinnularia divergentissima** (Grun.) Cl. (Fig. 30)

Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 59-60 ? (without name) ; t. 388, f. 23-24 ; Hustedt, 1930, Bacil. 320, 581 ; Berg, Å., 1945, *Ark. Bot.* 32 A (1) : 15, t. 4, f. 159 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 57, f. 1077 a-d (= v. *genuina* A. Cl.).

Valves 50-55.2 μ long and 7.6 μ broad, narrowly lanceolate with broadly rounded capitate ends. Raphe thin and straight with central pores slightly unilaterally bent and terminal fissures curved. Axial area very narrow, linear ; central area large, rhomboid, reaching the sides. Striae 11-13 in 10 μ, very strongly radial in the middle and convergent at the ends, the angle formed between radial and convergent striae is about 115°.

Habitat : Fresh water. Collected from ponds at Goregaon, Andheri, Vile-Parle, and other places. Stray forms also were collected from Powai lake and streams at Borivli. Not common.

30. **Pinnularia termes** Ehr. v. **termitina** (Ehr.) A. Cl. (Fig. 31)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 60, f. 1085 c ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 64 (= *Navicula termitina* Ehr.).

Valves 50-55 μ long and 7.2 μ broad, narrowly linear with distinctly concave sides and strongly constricted, somewhat produced, broadly capitate rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area linear ; central area wide, rhomboid, reaching the sides. Striae 10-12 μ 10 μ, well marked, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Vihar lakes quite frequently. Stray specimens also were collected from ponds at Andheri and Goregaon and a tank at Bandra. Not common.

31. **Pinnularia mesolepta** Ehr. v. **stauroneiformis** Grun. (Fig. 32)

Hustedt, 1914, *Arch. Hydrobiol.* 10 : 142, t. 1, f. 12 ; Skvortzow, B. W., 1928, *Philipp. J. Sci.* 35 : 43, pl. 2, f. 20 ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 71 (= *Navicula mesolepta* Ehr. v. *stauroneiformis* A. S. ?).

Valves 57.6-60 μ long and 9.10 μ broad, linear with strongly triundulate sides and somewhat narrowed, produced, broadly rounded capitate ends. Raphe thin and straight with central pores unilaterally bent or not ; terminal fissures curved. Axial area somewhat narrowly linear ; central area large, quadrate, reaching the sides. Striae 9-10 in 10 μ, coarse, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from ponds at Goregaon, Dahisar, Vile-Parle, Jogeshwari, streams at Borivli, tank at Bandra, and Powai lake, mostly in a small number.

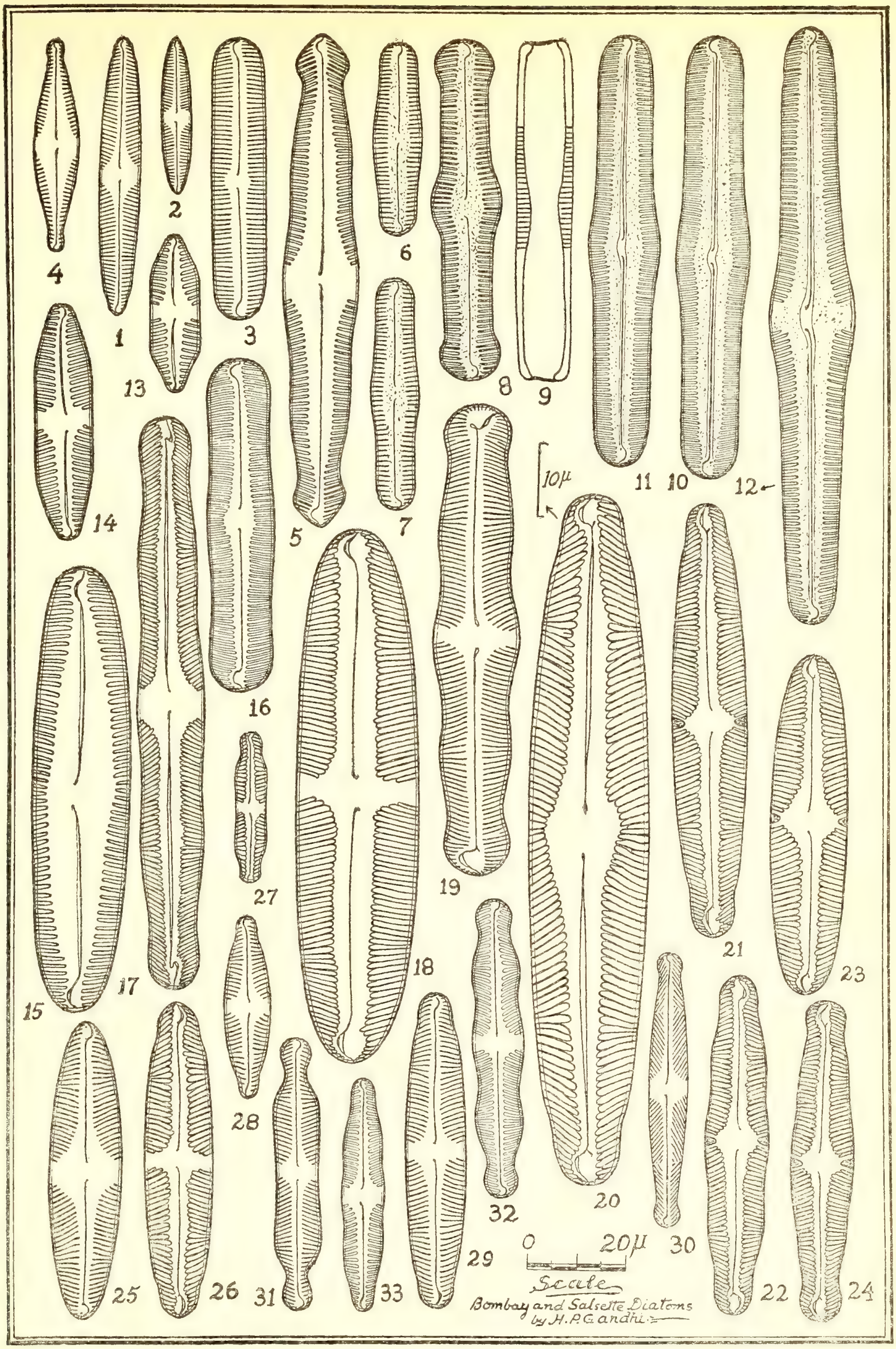
32. **Pinnularla mesolepta** v. **indica** v. nov. (Figs. 33, 35)

Valvae 38.7-50 μ longae atque 8.2-8.8 μ latae, lineari-lanceolatae, marginibus distincte triundulatis, apicibus leniter constrictis, elongato-rotundatis. Raphe tenuis et recta, fissuris terminalibus curvatis. Area axialis sublinearis; area centralis magna, rhomboidea, ad latera perveniens. Striae circiter 9 in 10 μ, crassae, radiales in medio ac in utroque apice convergentes. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—4.

Valves 38·7-50 μ long and 8.2-8.8 μ broad linear-lanceolate with distinct triundulate sides and softly constricted, produced rounded ends. Raphe thin and straight with terminal fissures curved. Axial area, sublinear ; central area large, rhomboid, reaching the sides. Striae about 9 in 10 μ, coarse, radial in the middle and convergent at the ends.

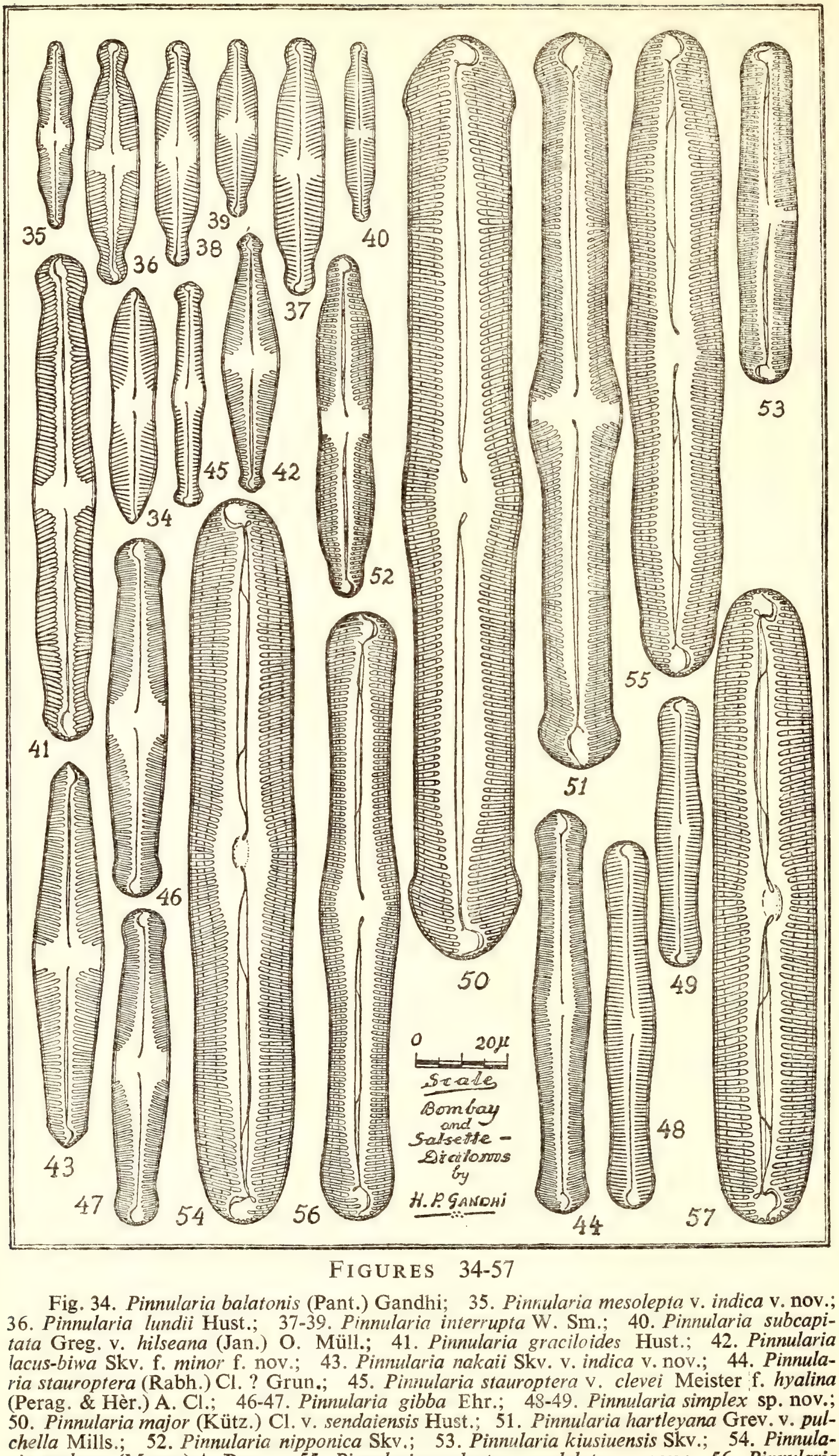
Habitat : Fresh water. Collected from pools and ponds at Wadala as a frequent form.

This diatom agrees closely with *P. mesolepta* Ehr. and its forms and varieties (Hustedt, 1930, Bacil. 319, f. 575 a-b ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 60-61, f. 1087), in triundulate sides, raphe, axial and central areas and the arrangement of striae. However, it differs from them in having linear-lanceolate outline with softly constricted produced ends. It is a more robust diatom than *P. mesolepta* f. *angusta* Cl. (Hustedt, *op. cit.* f. 575 b=*P. pulchra* Østr. v. *genuina* A. Cl. Cleve-Euler, *op. cit.* 27, f. 1025 d), since the length to breadth proportions here are 4.7-5.7 : 1, in contrast to 7-8 : 1 as indicated by Hustedt. With



FIGURES 1-33

Fig. 1. *Pinnularia appendiculata* (Ag.) Cl.; 2. *Pinnularia molaris* Grun.; 3 *Pinnularia finlandica* A. Cl.; 4. *Pinnularia braunii* (Grun.) Cl.; 5. *Pinnularia polyonca* (Bréb.) O. Müll.; 6-7. *Pinnularia acrosphaeria* (Bréb.) W. Sm. v. *minor* Cl.; 8-9. *Pinnularia acrosphaeria* v. *sandvicensis* A. S.; 10-11. *Pinnularia dolosa* sp. nov.; 12. *Pinnularia dolosa* v. *chariessa* v. nov.; 13-14. *Pinnularia ueno* Skv. v. *wadalensis* v. nov.; 15. *Pinnularia brevicostata* Cl. v. *indica* v. nov.; 16. *Pinnularia meisteri* A. Cl. v. *scandica* A. Cl.; 17. *Pinnularia stomatophora* Grun. v. *triundulata* Font.; 18. *Pinnularia episcopalis* Cleve; 19. *Pinnularia platycephala* (Ehr.) Cl.; 20. *Pinnularia scythica* (Pant.) Gandhi; 21. *Pinnularia divergens* W. Sm.; 22. *Pinnularia divergens* v. *undulata* Hèr & Perag.; 23. *Pinnularia divergens* v. *elliptica* Grun.; 24. *Pinnularia divergens* v. *capitata* Mills; 25. *Pinnularia brébissonii* (Kütz.) Cl.; 26. *Pinnularia brêbissonii* v. *producta* A. Cl.; 27. *Pinnularia brébissonii* v. *producta* f. *biundulata* (O. Müll) A. Cl.; 28-29. *Pinnularia microstauron* (Ehr.) Cl.; 30. *Pinnularia divergentissima* (Grun.) Cl.; 31. *Pinnularia termes* Ehr. v. *termitina* (Ehr.) A. Cl.; 32. *Pinnularia mesolepta* Ehr. v. *stauroneiformis* Grun.; 33. *Pinnularia mesolepta* v. *indica* v. nov.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Diatoms
by
H. P. GANDHI

FIGURES 34-57

Fig. 34. *Pinnularia balatonis* (Pant.) Gandhi; 35. *Pinnularia mesolepta* v. *indica* v. nov.; 36. *Pinnularia lundii* Hust.; 37-39. *Pinnularia interrupta* W. Sm.; 40. *Pinnularia subcapitata* Greg. v. *hilseana* (Jan.) O. Müll.; 41. *Pinnularia graciloides* Hust.; 42. *Pinnularia lacus-biwa* Skv. f. *minor* f. nov.; 43. *Pinnularia nakaii* Skv. v. *indica* v. nov.; 44. *Pinnularia stauroptera* (Rabh.) Cl. ? Grun.; 45. *Pinnularia stauroptera* v. *clevei* Meister f. *hyalina* (Perag. & Hèr.) A. Cl.; 46-47. *Pinnularia gibba* Ehr.; 48-49. *Pinnularia simplex* sp. nov.; 50. *Pinnularia major* (Kütz.) Cl. v. *sendaiensis* Hust.; 51. *Pinnularia hartleyana* Grev. v. *pulchella* Mills.; 52. *Pinnularia nipponica* Skv.; 53. *Pinnularia kiusiuensis* Skv.; 54. *Pinnularia neglecta* (Mayer) A. Berg.; 55. *Pinnularia neglecta* v. *undulata* v. nov.; 56. *Pinnularia pseudoluculenta* sp. nov.; 57. *Pinnularia streptoraphe* Cleve.

these differing features, therefore, the present specimens are tentatively considered to be a new variety.

33. **Pinnularia lundii** Hust. (Fig. 36)

Hustedt, 1954, *Arch. Hydrobiol.* 48 (4) : 474, f. 61-63.

Valves 40-53.7 μ long and 9.5-11.5 μ broad, linear-lanceolate or linear-elliptical with constricted, broadly capitate rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area moderate, narrowly lanceolate ; central area wide, reaching the sides. Striae 11-13 in 10 μ, coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams, Powai and Vihar lakes, in good number ; elsewhere seen rather as a stray form.

A form in my earlier paper described as *P. biceps* Greg. v. *amphicephala* (May.) A. Cl. (Gandhi, 1958, *J. Bombay nat. Hist. Soc.* **55** : 498, f. 23), I am not sure if it could be this species, since my Kolhapur form shows slightly a different arrangement of the middle striae as a result of which the central area appears to be much enlarged.

34. **Pinnularia interrupta** W. Sm. (Figs. 37-39)

Habitat : Fresh water. Collected from various wet situations in the region. It was found to be a variable species and the typical forms noted from the region are herewith depicted. Quite common in the area.

35. **Pinnularia subcapitata** Greg. v. **hilseana** (Jan.) O. Müll. (Fig. 40)

Hustedt, 1930, Bacil. 317, f. 572 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 65, 1090 n-r ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 65 (=*Navicula hilseana* Janisch).

Valves 39-42 μ long and 6 μ broad, narrow, linear with or without indistinctly concave sides and constricted, produced subcapitate rounded ends. Raphe thin and straight, terminal fissures curved. Axial area very narrow ; central area large, reaching the sides. Striae 11-13 in 10 μ, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Vihar lakes as a common form. Isolated or stray specimens also were noted from streams at Borivli.

36. **Pinnularia graciloides** Hust. (Fig. 41)

Habitat : Fresh water. Collected from Powai and Vihar lakes as a common form and stray specimens were recorded from Borivli streams.

37. **Pinnularia conica** Gandhi

Habitat : Fresh water. Collected from various ponds, large pools and tanks. It occurred mostly in small number. Common.

38. **Pinnularia lacus-biwa** Skv. f. **minor** f. nov. (Fig. 42)

Valvae 54-56 μ longae atque 12.4 μ latae, lanceolatae, apicibus constrictis, capitato-cuneatis. Raphe crassa sed simplex, ornata poris aliquantum unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis lanceolata; area centralis ampla, rhomboidea, ad latera perveniens. Striae 8-9 in 10 μ, crassae, radiales in medio ac convergentes ad apices. Typus lectus a H. P. Gandhi in lacu Powai die 28-1-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—18.

Valves 54.56 μ long and 12.4 μ broad, lanceolate with constricted capitate-cuneate ends. Raphe thick but simple with central pores slightly unilaterally inclined and terminal fissures curved. Axial area lanceolate ; central area large, rhomboid, reaching the sides. Striae 8-9 in 10 μ, thick, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Rather rare, since only a few specimens were seen.

This diatom agrees well with *P. lacus-biwa* Skv. (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 280, pl. 6, f. 8) in the outline, raphe, axial and central areas, and the arrangement of the striae. However, the present specimens differ in being much smaller than the type. It is, therefore, provisionally considered to be a new form.

39. **Pinnularia nakaii** Skv. v. **indica** v. nov. (Fig. 43)

Valvae 80-83.6 μ longae atque 15.4 μ latae, lanceolatae, apicibus aliquantum productis late cuneatis. Raphe crassa sed simplex et recta, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis ampla, lineari-lanceolata ; area centralis magna, ad margines perveniens. Striae 7-8 in 10 μ, crassae, radiales in medio atque in utroque apice convergentes. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—20.

Valves 80-83.6 μ long and 15.4 μ broad, lanceolate with slightly produced, broadly cuneate ends. Raphe thick but simple and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, linear-lanceolate ; central area large, reaching the sides. Striae 7-8 in 10 μ, thick, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai lake rather as a stray diatom.

This diatom agrees well with *P. nakaii* Skv., as described by Skvortzow (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 280, pl. 8, f.4), in the outline, raphe, axial and central areas, and the nature of striae and their arrangement. However, the local specimens differ in being comparatively smaller, broader hence more lanceolate, and the ends are not marked to be capitate. With these differences observed, it is therefore considered to be a new variety.

Section TABELLARIAE Cleve

40. **Pinnularia stauroptera** (Rabh.) Cl. ? Grun. (Fig. 44)

Cleve-Euler, A., 1951-55, Diat. Schwed, Finn.—IV, 66, f. 1091 a-c (=v. *genuina* Mayer) ; Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 569, t. 19, f. 9-10 (=*P. stauroptera* Grun.) ; 1930, Bacil. 327, f. 600 a-b (=*P. gibba* Ehr.) ; Donkin, A. S., 1871-73, Brit. Diat. III, 70, pl. 12, f. 3 (=*Navicula tabellaria* Ehr.) ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 50-51 (=*N. gibba* (Pinn.) Ehr.) ; Van Heurck, 1896, Treat. Diat. 172, pl. 2, f. 86 (=*N. tabellaria* Ehr.).

Valves 66-88.7 μ long and 12.6-13 μ broad, linear, inflated in the middle with swollen rounded ends somewhat cuneate. Raphe thin and straight with central pores approximate and unilaterally bent and terminal fissures curved. Axial area very broad, linear-lanceolate ; central area not quite defined. Striae about 10 in 10 μ, coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams, Powai and Vihar lakes, tank at Bandra, and as a stray form in several large bodies of water in the region. Fairly distributed.

This species I have referred to *P. stauroptera* according to Cleve-Euler, since from my some years of collections and observations I felt it to be different from *P. gibba* Ehr., which is described in the following. The references cited here all more or less point out the present species and it appears that no two opinions are the same for it.

41. **Pinnularia stauroptera** v. **clevei** Meister f. **hyalina** (Perag. & Hér.) A. Cl. (Fig. 45)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 57, f. 1091 f.

Valves 49-52 μ long and 7.2 μ broad, weakly silicified, linear-lanceolate with weakly triundulate sides, middle inflation rather more wide and prominent, ends very broad capitate-rounded-cuneate. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, linear or sublinear ; central area large, rhomboid, reaching the sides. Striae about 10 in 10 μ, somewhat delicate, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from hilly streams at Chembur, Borivli, and Powai lake, rather as a stray form.

42. **Pinnularia gibba** Ehr. (Figs. 46-47)

Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 45-47 ; Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 42, pl. 7, f. 2-3 ; Van Heurck, 1896, Treat. Diat. 172, pl. 2, f. 88 (=*Navicula gibba* Ehr.) ; Pantocsek, J., 1902, *Res. Wiss. Erf. Balat.* 2 (2) : 33, t. 3, f. 66 (=*Nav. stauroptera* Grun. v. *parva* Grun.) ; Schönfeldt, H., 1913, Bacil. 109, f. 235 (=*P. gibba* W. Sm. ? Ehr.) ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 57, f. 1091 bb (=*P. stauroptera* ?).

Valves 68-79 μ long and 11-12.6 μ broad, linear-lanceolate with slight but uniformly convex sides and at the extremities abruptly swollen, broadly rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area narrowly lanceolate ; central area very large, rhomboid, reaching the sides. Striae 8-9 rarely up to 10 in 10 μ, very coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai, Vihar, and Tansa lakes as a frequent form but stray specimens were obtained from several large bodies of water in the region. Common.

Krishnamurthy has described a form under *P. gibba* Ehr. (Krishnamurthy, *V.*, 1954, *J. Indian bot. Soc.* 33 : 369, f. 43). This is shown to be an arcuate type with clear longitudinal bands on the striae, which are characteristically apparent only in ' Majores, Complexae, Vitreatae ' groups. Moreover, it is shown to have complex or subcomplex raphe. These features as given by Krishnamurthy for *P. gibba* appear to be strange and unknown in the literature, particularly the one he has cited. It seems that the said author has erroneously determined this as well as several other diatoms of his paper.

43. **Pinnularia simplex** sp. nov. (Figs. 48-49)

Valvae 59-80 μ longae atque 9-11.4 μ latae, lineares, marginibus concavis centrum inter et polos, apicibus late-rotundatis. Raphe tenuis et recta, ornata poris centralibus aliquantum unilateraliter inclinatis ac fissuris terminalibus curvatis. Area axialis angusta, linearis ; area centralis paulum dilatata. Striae 9-11 in 10 μ, aliquantum radiales in medio ac in utroque apice convergentes. Typus lectus a H.P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—10.

Valves 59-80 μ long and 9-11.4 μ broad, linear with margins concave in between the middle and the ends, ends broadly rounded. Raphe thin and straight with central pores slightly unilaterally bent and terminal fissures curved. Axial area narrow, linear ; central area slightly widened. Striae 9-11 in 10 μ, slightly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from pools and ponds at Wadala, Goregaon, Jogeshwari, Andheri, and some other places. It occurred usually in a small number.

This diatom does not agree well with any of the similar looking species of *Pinnularia.* It is, therefore, tentatively considered to be a new species.

Section MAJORES Cleve

44. **Pinnularia major** (Kütz.) Cl. v. **sendaiensis** Hust. (Fig. 50)

Schmidt, A., 1874-1944, Atlas Diat. t. 387, f. 3.

Valves 201-207 μ long and 26.2-27 μ broad, linear, distinctly inflated in the middle, sides parallel, ends swollen and subcuneate-rounded. Raphe thick with central pores unilaterally bent and terminal fissures somewhat obliquely curved. Axial area wide 1/4 to nearly 1/3 the width of the valve, linear ; central area dilated. Striae 5-5.5 in 10 μ, thick, radial in the middle and convergent at the ends with fairly wide longitudinal bands quite evident.

Habitat : Fresh water. Collected from Powai lake rather in a small number. Rare.

This diatom agrees well with the type illustrated in the 'Atlas', in the outline, raphe, and striae. However, it appears to be somewhat smaller and has rounded cuneate ends, hence it slightly differs. Skvortzow has described a form *P. hustedtii* Meister (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 43, pl. 8, f. 5) which is very much like the present one in the outline, apices, raphe, striae, and other details. However, *P. hustedtii* is a larger and slimmer form (221 x 17 μ, striae 9 in 10 μ) with more number of striae per 10 μ, than is the case with the present form. Again, the material of the present species is very scarce. It is therefore difficult to remark in any way. Presently, I refer my specimen to Hustedt's *P. major* v. *sendaiensis,* of course provisionally, since the striae number as also many other details approximate to it.

45. **Pinnularia hartleyana** Grev. v. **pulchella** Mills (Fig. 51)

Mills, F. W., 1932, *J. roy. microsc. Soc.* 52 : 390, pl. 2, f. 19-20.

Valves 149-160 μ long and 18-21 μ broad, linear, strongly inflated in the middle, sides almost parallel, ends swollen and subrounded. Raphe thick and straight with central pores conspicuous and unilaterally bent and terminal fissures large comma-shaped. Axial area about 1/4-1/3 the width of the valve, linear ; central area large and reaching the sides. Striae 8-9 in 10 μ, thick, strongly radial in the middle and convergent at the ends with faint longitudinal bands.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Rather rare.

This diatom agrees well with the type described and illustrated by Mills except that the local forms have smaller size.

46. **Pinnularia nipponica** Skvortzow (Fig. 52)

Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 45, pl. 7, f. 12 ; 281, pl. 3, f. 8, pl. 8, f. 5.

Valves 70-75 μ long and 11.2-12 μ broad, linear, sides concave in the middle with constricted, broadly produced rounded ends. Raphe thick, subcomplex with central pores unilaterally bent and terminal fissures curved. Axial area linear or sublinear ; central area large, reaching the sides. Striae 8-10 in 10 μ, thick, radial in the middle and convergent at the ends with longitudinal bands faintly visible.

Habitat : Fresh water. Collected from ponds and pools at Wadala and Powai lake usually as a stray form. Rare.

Section COMPLEXAE Cleve

47. **Pinnularia kiusiuensis** Skvortzow (Fig. 53)

Skvortzow, B. W., 1937, *Philipp. J. Sci.* 62 : 206, pl. 3, f. 4.

Valves 72-75 μ long and 13.6 μ broad, linear, slightly swollen in the middle with swollen rounded ends. Raphe thick, more or less complex with central pores unilaterally bent and terminal fissures thick and curved. Axial area linear about 1/5 the width of the valve ; central area large and unilaterally reaching the side. Striae 9-10 in 10 μ, thick, slightly radial in the middle and convergent at the ends with longitudinal bands somewhat narrow but distinct.

Habitat : Fresh water. Collected from Powai and Vihar lakes in a small number. Rare in the locality.

This species agrees well with the type described by Skvortzow, except that the ends here are somewhat more rounded.

48. **Pinnularia neglecta** (Mayer) Å. Berg (Fig. 54)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 80, f. 1112.

Valves 157.5-163 μ long and 23-24 μ broad, linear, slightly inflated in the middle with gradually swollen, weakly narrowed rounded ends. Raphe thick and complex with central pores unilaterally bent and terminal fissures thick, slightly obliquely large-comma-shaped. Axial area fairly wide, about 1/4-1/3 the width of the valve ; central area somewhat dilated and apparent. Striae 6-7 in 10 μ, thick radial in the middle and convergent at the ends with fairly broad, clear longitudinal bands.

Habitat : Fresh water. Collected from Powai and Vihar lakes in good numbers.

49. **Pinnularia neglecta** v. **undulata** v. nov. (Fig. 55)

Valvae 137-140.2 μ longae atque 21.6-22 μ latae, robustae, lineares, ad margines triundulatae, apicibus constrictis, late elongato-rotundatis. Raphe crassa et complexa, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis 1/4-1/3 latitudinis valvae, linearis ; area centralis aliquantum dilatata. Striae 6-7 in 10 μ, crassae, radiales in medio ac convergentes in utroque apice, vittis longitudinalibus distincte evolutis. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—62.

Valves 137-140.2 μ long and 21.6-22 μ broad, robust, linear with triundulate sides and constricted, broadly produced rounded ends. Raphe thick and complex with central pores unilaterally bent and terminal fissures curved. Axial area 1/4-1/3 the width of the valve, linear ; central area slightly dilated. Striae 6-7 in 10 μ, thick, radial in the middle and convergent at the ends with longitudinal bands distinct.

Habitat : Fresh water. Collected from Powai lake and streams at Borivli. Stray forms also were recorded from Vihar and Tansa lakes. Rather rare.

This diatom agrees well with *P. neglecta* (May) Å. Berg, described above, in all the features except that the valves are more robust with distinct triundulate sides and constricted, broadly produced rounded ends. It is, therefore, considered to be a new variety.

50. **Pinnularia pseudoluculenta** sp. nov. (Fig. 56)

Valvae 132-140 μ longae atque 17.6-18 μ latae, anguste lineares, marginibus concavis centrum inter et polos, apicibus gradatim tumidis ac late rotundatis. Raphe crassa et complexa, ornata poris centralibus unilateraliter inclinatis conspicuis, fissuris terminalibus oblique curvatis. Area axialis circiter 1/3 latitudinis valvae, lineari-lanceolata ; area centralis fere dilatata vel quadrata. Striae 7-8 in 10 μ, crassae, aliquantum radiales in medio atque in utroque apice convergentes, vittis tenuibus sed distinctis. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 1944, 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—35.

Valves 132-140 μ long and 17.6-18 μ broad, narrowly linear with concave sides between the middle and the ends, ends gradually swollen and broadly rounded. Raphe thick and complex with central pores conspicuous and unilaterally bent and terminal fissures obliquely curved. Axial area about 1/3 the width of the valve, linear-lanceolate ; central area almost dilated to quadrate. Striae about 7-8 in 10 μ, thick, slightly radial in the middle and convergent at the ends with bands narrow but distinct.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, as a frequent form. Not common in the region.

This species resembles *P. conspicua* (A.S.) Cl., as illustrated by Mills (Mills, F. W., 1932, *J. roy. microsc. Soc.* 52 : 390, pl. 2, f. 22), in the outline and the arrangement of the striae. However, the present specimens are much smaller and very sleek and have comparatively much wider axial area ; hence they differ. Morever, in the reference cited by Mills [Schmidt, A., 1874-1944, Atlas Diat. t. 43, f. 10-11 (=*Navicula conspicua* A. S.)] the illustrations appear to be very different from that of Mills (Mills seems to recognise the fact) and the present forms ; hence the comparison is difficult. Further, Cleve-Euler's *P. alandica* A. Cl. (Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 80, f. 1112 A) also appears to be different as it has broader valves, produced-cuneately-rounded apices, and fewer striae per 10 μ, although it has somewhat a similar shape. Again, the present forms compare well with *Navicula luculenta* A. S. which is in fact a *Pinnularia* type (Schmidt, A., *op. cit.* t. 43, f. 12) in the outline, range of dimensions, and perhaps the striae. However, the present specimens show much wider axial area, well defined quadrate central area, comparatively shorter striae with narrow longitudinal bands ; hence they differ. In the literature no other species are known with which the satisfactory comparison could be made, hence the present specimens are considered to be a new species.

Section VITREATAE Å. Berg

51. **Pinnularia streptoraphe** Cleve (Fig. 57)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 572, t. 19, 8 ; 1930, Bacil. 337, f. 620 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 85, f. 1117 a-c (=v. *genuina* A. Cl.) ; Schmidt, A., 1874-1944, Atlas Diat. t. 42, f. 7 (=nomen nudum).

Valves 140-160 μ long and 22.5-24 μ broad, linear with broadly rounded ends. Raphe thick, very strongly complex and folded with central pores prominent and unilaterally bent and terminal fissures thick and obliquely comma-shaped. Axial area about 1/4 the width of the valve, linear ; central area only slightly dilated. Striae 5-5.5, rarely 6 in 10 μ, thick, radial in the middle and convergent at the ends with fairly broad very conspicuous longitudinal bands.

Habitat : Fresh water. Borivli streams, Powai, Vihar, and Tansa lakes. Fairly common.

Genus **AMPHIPRORA** Ehrenberg 1843, emend. Cleve 1891

52. **Amphiprora alata** Kütz. (Fig. 58)

Hustedt, 1930, Bacil. 340, f. 625 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—V, 32, f. 1402 a-d (=v. *genuina* A. Cl.).

Frustules 48-59 μ long and 21-23 μ broad in the middle and 35-37 μ at the broadest, strongly siliceous, torsive in the longitudinal plane, oblong-elliptical, deeply constricted in the middle with rounded truncate ends in the girdle view. Connecting zone with numerous longitudinal plaits, broad and somewhat sigmoid. Keel sigmoid with undulate keel projections. Striae 16-18 in 10 μ, fine and punctuate.

Habitat : Brackish water. Collected from Mahim and Chembur creeks in good numbers and as a common form.

53. **Amphiprora lata** Grev. v. **angustior** McCall (Fig. 59)

McCall, D., 1933, *J. Linn. Soc.* (*Bot.*) 49 : 268, 26.

Frustules 98-116 μ long and 21.6-22 μ broad in the middle and 30-33.5 μ at the broadest, weakly siliceous, oblong, constricted in the middle with truncate rounded ends in the girdle view. Connecting zone with numerous longitudinal plaits almost straight with about 22 fine striae in 10 μ. Keel broad, sigmoid with uniformly arcuate keel projections. Striae about 13-14 in 10 μ, rather fine.

Habitat : Brackish water. Collected from Mahim creek usually in a small number. Very stray specimens also were collected from Chembur and Bhayandar creeks.

Genus **AMPHORA** Ehrenberg 1840

54. **Amphora ovalis** Kütz. v. **gracilis** (Ehr.) Cl. (Fig. 60)

Van Heurck, 1896, Treat. Diat. 127, pl. 1, f. 16 ; Hustedt, 1930, Bacil. 342 (=f. *gracilis* (Ehr.) Cl.) ; Cleve-Euler, A. 1951-55, Diat. Schwed. Finn.—III, 91, f. 667 b ; Schmidt, A., 1874-1944, Atlas Diat. t. 26, f. 108 (=*A. ovalis* Kütz.).

Frustules 65-70 μ long and 27-29.5 μ broad, slender than the type, elliptical with truncate ends in girdle view. Valves lunate with convex dorsal side and concave ventral side with rounded ends. Raphe arcuate with dorsally bent conspicuous central pores. Axial area very narrow ; central area large, quadrate, reaching the ventral side. Striae 12-13 in 10 μ, coarsely punctuate, radial on the dorsal side but on the ventral side radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from pools and ponds at Wadala, Vile-Parle, Goregaon, and some other places. Usually collected in a small number.

This diatom agrees well with the type described by Van Heurck and others. The maximum length given by Cleve-Euler is 40 μ, from which the present specimens differ in being much larger. It also resembles *A. libyca* Ehr. (Cleve-Euler, *op. cit.* 90 f. 666 a-b (=v. *typica* A. Cl.), but differs in not having clearly defined longitudinal hyaline bands.

55. **Amphora ovalis** Kütz. v. **pediculus** Kütz.

Habitat : Fresh water. Widely distributed in the locality and sometimes abundant.

56. **Amphora acutiuscula** Kütz. (Fig. 61)

Van Heurck, 1896, Treat. Diat. 134, pl. 1, f. 5 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—III, 98, f. 686 a-b ; Schmidt, A., 1874-1944, Atlas Diat. t. 26, f. 59 (=*A. lineata* Greg.) ; Foged, N., 1957, *Nat. Hist. Rennell Isl.* 3 : 75, pl. 9, f. 5 ? (=*A. sp.*)

Frustules 32-38 μ long and 15-16 μ broad with abruptly constricted produced truncate ends in girdle view. Valves semi-lanceolate, 7-8 μ broad, with straight ventral side and produced, somewhat capitate ends. Raphe thin and straight rather delicate. Axial area very narrow. Striae 14-18 in 10 μ, radial, indistinctly punctuate and rudimentary on the ventral side.

Habitat : Brackish water. Collected from Mahim and Chembur creeks fairly frequently.

Genus **CYMBELLA** Agardh 1830

57. **Cymbella turgida** (Greg.) Cl.

Habitat : Fresh water. Widely distributed in the area but always collected in smaller numbers. Common.

58. **Cymbella ventricosa** Kütz.

Habitat : Fresh water and wet soils. Common throughout the region.

59. **Cymbella gracilis** (Rabh.) Cl. (Fig. 62)

Hustedt, 1930, Bacil. 359, f. 663 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 129, f. 1184 a-b (=v. *schmidtii* A. Cl.) ; Schmidt, A., 1874-1944, Atlas Diat. t. 10, f. 36-37, 39-40 (=*Encyonema gracile* Rabh.)

Valves 32.4-36 μ long and 5.4- μ broad, asymmetrical, narrow semi-lanceolate with ventral side almost straight, ends acutely rounded sometimes slightly constricted and weakly bent on the ventral side. Raphe thin and straight, strongly excentric and close to the ventral side. Axial area very narrow ; central area very small. Striae 12-14 in 10 μ, fine and slightly radial, ventral side striae marginal.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes usually in good number.

This species agrees well with the type described Cleve-Euler and others except that the ventral side sometimes noted to be slightly concave as indicated by Cleve-Euler in f. 1184 a.

60. **Cymbella yarrensis** (A. S.) Cl. (Fig. 63)

Schmidt, A., 1874-1944, Atlas Diat. t. 379, f. 21-22; t. 71, f. 16 (= *Encyonema* ? *yarrensis* A. S.).

Valves 75-80 μ long and 12.6-13 μ broad, asymmetrical-lanceolate with dorsal side more convex than the ventral one with acutely rounded ends. Raphe thin and straight, clearly excentric with terminal fissures dorsally directed. Axial area narrow very narrowly lanceolate ; central area slightly widened. Striae 12-14 in 10 μ, strongly radial in the middle but less so towards the ends and somewhat closer. In some cases the end striae tended to be probably perpendicular to the middle line.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Only stray specimens were recorded.

This species agrees well with the type illustrated in the ‘ Atlas ’, in the outline, length-breadth proportions, raphe and strongly radial striae in the middle. However, the end striae noted in the local forms are not necessarily perpendicular to the middle line. I have referred these specimens to the said species with some amount of hesitation, but these definitely do not agree with any other similar-looking species.

61. **Cymbella amphicephala** Naeg.

Habitat : Fresh water. Collected from streams at Borivli, pools at Kanheri caves, Powai and Vihar lakes, usually as a common form.

62. **Cymbella leptoceros** (Ehr. ?) Grun. v. **rostrata** Hust. f. **indica** f. nov. (Fig. 64)

Valvae 38-43 μ longae atque 12-12.5 μ latae, asymmetricae, subrhomboideae, latere dorsali valde convexo, ventrali aliquantum convexo, apicibus constrictis ac elongato-rotundatis. Raphe crassa, arcuata, leniter centrica, poris centralibus conspicuis, fissuris terminalibus ad marginem dorsalem versus flexis. Area axialis sat ampla, anguste lanceolata ; area centralis paululum dilatata. Striae 9-12 in 10 μ, crasse lineatae bis seriatae, ubique radiales ac in utroque apice proxime positae. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—48.

Valves 38-43 μ long and 12-12.5 μ broad, asymmetrical, subrhomboid, dorsal side strongly convex than the ventral side with constricted, slightly produced rounded ends. Raphe thick, arcuate, somewhat centric with central pores conspicuous and terminal fissures dorsally bent. Axial area fairly wide and narrowly lanceolate ; central area very slightly dilated. Striae 9-12 in 10 μ, coarsely lineate in double rows, throughout radial and at the ends closely set.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake in a small number.

This diatom agrees well with *Cymbella leptoceros* (Ehr. ?) Grun. v. *rostrata* Hust. (Hustedt. 1944, *Arch. Hydrobiol.* 39 : 132, f. 52-54) in the outline, striae and other details. However, the present forms show rather rhombic shape and less conspicuously produced rostrate ends. It is, therefore, considered to be a new form.

63. **Cymbella austriaca** Grun. v. **subrhomboidea** (Østrup) A. Cl.

Habitat : Fresh water. Collected from streams at Borivli and Kanheri caves. Fairly common.

64. **Cymbella tumida** (Bréb.) V. H. (Figs. 65-66)

Schmidt, A., 1874-1944, Atlas Diat. t. 376, f. 4-7 ; t. 10, f. 28-30 (= *C. stomatophora* Grun.) ; Van Heurck, 1896, Treat. Diat. 148, pl. 1, f. 42 ; Hustedt, 1930, Bacil. 366, f. 677 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 166, f. 1255 a [=v. *genuina* (Grun.) A. Cl.].

Valves 53-65 μ long and 18-19.5 μ broad, asymmetrical, boat-shaped, strongly convex on the dorsal side, on ventral side straight, medially gibbous, feebly concave or triundulate with strongly constricted, broadly produced rounded-truncate ends. Raphe thick, arcuate, excentric with distinct central pores and dorsally reflexed terminal fissures. Axial area rather narrow, linear ; central area large roundish or subquadrate with a luna on the dorsal side and a pore or elongated marking on the ventral side. Striae 7.5-9 in the middle up to 11 in 10 μ towards the ends, clearly and coarsely punctate and radial throughout.

Habitat : Fresh water. Collected from Powai, Vihar, and Tansa lakes as a common and frequent form. A smaller number of forms also were collected from Bandra tank and some other places. Not widely distributed.

65. **Cymbella powaiana** sp. nov. (Fig. 67)

Valvae 57.6-60 μ longae atque 18-19 μ latae, asymmetricae, cymbiformes, latere dorsali valde convexo, ventrali vero recto sed paululum tumido ad medium, apicibus constrictis in dorso, distincte productis et subtruncatis. Raphe crassa, arcuata, leniter centrica, ornata poris centralibus distinctis atque fissuris terminalibus ad marginem dorsalem versus flexis. Area axialis sat ampla, linearis ; area centralis ampla subrotundata absque stigmatibus. Striae 7-8 in 10 μ, crasse lineatae, punctis circiter 18-20 in 10 μ, ubique radiales. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—77.

Valves 57.6-60 μ long and 18-19 μ broad, asymmetrical, boat-shaped, dorsal side strongly convex, ventral side straight with a slight inflation in the middle ; ends constricted on the dorsal side, distinctly produced and subtruncate. Raphe thick, arcuate, nearly central with central pores distinct and terminal fissures reflexed towards the dorsal side. Axial area fairly wide, linear ; central area large somewhat roundish without any stigmata. Striae 7-8 in 10 μ, coarsely lineate with puncta about 18-20 in 10 μ, throughout radial.

Habitat : Fresh water. Collected from Powai lake along with the above type in a small number. Stray specimens also were collected from streams at Borivli and Vihar lake.

This species does not satisfactorily agree with any other similar looking types in the literature, hence it is regarded as a new species.

66. **Cymbella aspera** (Ehr.) Cl.

Habitat : Fresh water. Collected from streams at Borivli, Chembur hills, Powai, Vihar and Tansa lakes, usually in good number, from among the dead vegetable matter scattered around the borders. It was also found to form slimy encrustations on stony or rocky substratum.

67. **Cymbella bengalensis** Grun.

Habitat : Fresh water. Mostly collected from the streams at Borivli and Powai lake. Not common.

Genus **GOMPHONEMA** Agardh 1824

68. **Gomphonema constrictum** Ehr. v. **capitata** (Ehr.) Cl. (Fig. 68)

Schmidt, A., 1874-1944, Atlas Diat. t. 247, f. 33 ; Hustedt, 1930, Bacil. 377, f. 715 ; Van Heurck, 1896, Treat. Diat. 270, pl. 7, f. 297 (= *G. constrictum* v. *capitatum* Ehr.) ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 173, f. 1261 e-f ? [= *G.—v. capitatum* (Ehr.) Cl. f. *typica* May.].

Valves 47.5-50 μ long and 12.5-13 μ broad, broadly clavate with feebly constricted broadly produced subtruncate apex and attenuated rounded base. Raphe thick and straight. Axial area narrow, linear ; central area somewhat rhomboid, slightly unilateral with a stigma on the opposite side. Striae 10-12 in 10 μ, fine but clearly punctate and slightly radial.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake, in good number.

69. **Gomphonema constrictum** v. **indica** v. nov. (Fig. 69)

Valvae 45-47.5 μ longae atque 12.5 μ latae, clavatae, apice constricto, late elongato-rotundato. Striae circiter 11-12 in 10 μ, radiales atque distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi in lacu Powai die 28-1-1945, et positus in herbario proprio auctoris sub numero BOM-POW. —78.

Valves 45-47.5 μ long and 12.5 μ broad, clavate, apex constricted broadly produced and rounded. Striae about 11-12 in 10 μ, radial and clearly punctate. In all other characters resembles the type.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake, usually in a smaller number along with the type.

This diatom agrees well with above mentioned type in all characters except that the apical part is rather short, distinctly constricted, broadly produced and rounded. It is, therefore, considered as a new variety.

70. **Gomphonema acuminatum** Ehr. v. **turris** (Ehr.) Cl. (Figs. 70-71)

Valves 46-71.5 μ long and 11-14.4 μ broad and striae 9-10 to 12-13 in 10 μ.

While going through the literature, there appears to be some difficulty regarding the present species. The figure 70 very exactly agrees with Hustedt's *G. acuminatum* v. *turris* (Hustedt, 1911, *Abh. Nat. Ver. Bremen*, 20 : 293, t. 3, f. 36) and in the said reference, Schmidt's ' Atlas Diat.' t. 239, f. 31-36, illustrations are considered to be identical. In fact, of the ' Atlas ' t. 239, f. 32, 34 are rather more closely so, with the present as well as that of Hustedt (1911, *op. cit.*).

Cleve-Euler, however, considered Hustedt's (1911, *op. cit.*) specimens to be *G. montanum* Schum. v. *turriforme* A. Cl. (Cleve-Euler, A., 1951-55. Diat. Schwed. Finn.—IV, 182, f. 1276 a-b). The illustrations represented by her actually correspond more or less well with Hustedt's *G. lanceolatum* Ehr. v. *turris* (Ehr. e. p.) Hust. (Hustedt, 1936, *Arch. Hydrobiol., suppl.* 14 : 166, t. 3, f. 23). Hustedt renamed his 1936 (*op. cit.*) forms as *G. lanceolatum* f. *turris* (Ehr. e.p.) Hust. in his later work (Hustedt, 1938-39, *Arch. Hydrobiol., suppl.*, 15 : 437, t. 26, f. 8-11). If the illustrations of these two papers were to be compared, they differ much among themselves. The Java (1938, *op. cit.*) forms appear to be more broadly clavate from the middle part upwards with broadly cuneate ends and in the smaller forms therein the appearance goes as far as to suggest that *G. augur* Ehr. is getting evolved. These forms more or less come closer to *G. acuminatum* v. *turris* Ehr., ' Atlas ' t. 239, particularly the figures 31, 33, 35 except that the figs. in the ' Atlas ' have rather more pointed apex. But in any way all these are obviously dissimilar to present specimens as well to the one illustrated by Hustedt (1911, *op. cit.*).

Cleve-Euler's *G. montannum* v. *suecicum* Grun. (Cleve-Euler, *op. cit.*, 182, f. 1276 c) as well as of ' Atlas Diat.' t. 239, f. 32, 34 (= *G. acuminatum* v. *turris*) and t. 240, f. 4 (regarded as intermediate form between *G. acuminatum* and *G. augur* Ehr.) agree well here and with Hustedt's (1911, *op. cit.*).

Hustedt's *G. acuminatum* v. *turris* (Ehr.) Cl. (Hustedt, 1930, Bacil. 372, f. 687) befits anywhere between *G. acuminatum* v. *turris* of the 'Atlas' and *G. lanceolatum* v./f. *turris* (Ehr. e.p.) Hust., is being referred by Cleve Euler to *G. montanum* v. *turriforme* A. Cl. This form more or less corresponds well with my illustration (fig. 71). It also corresponds to a certain degree with ' Atlas ' t. 240, f. 18-20, particularly with f. 18 which is *G. acuminatum* v. *brasiliensis* Ehr., and much more with Skvortzow's *G. acuminatum* v. *turris* (Skvortzow, B. W., 1935, *Philipp. J. Sci.*, 57 : pl.3, f. 9 ; 1937, 61 : 51, pl. 12, f. 4 ; 1938, 66 : 356, pl. 1, f. 5 ?). Skvortzow recorded denser striae for some of his forms, particularly in forms collected from Kizaki lake.

Looking at *G. acuminatum* Ehr. itself which is a highly variable species, it may be assumed that *G. acuminatum* v. *turris* Ehr. is as well variable under different climatic, topographical, and habitat conditions, and as a result of that the same or different workers have given different illustrations and sometimes the considerations.

Yet, with a good deal of uncertainty and far fetched considerations, I presume the present diatoms to be *G. acuminatum* v. *turris* (Ehr.) Cl. a poly-phasic type. The references hitherto mentioned, all probably go to represent manifestations of the indicated type as has been suggested by Geitler (1932) in the case of several Pennate diatoms, Hendey (1951) in the case of *Achnanthes longipes* Ag., Lund (1945-46), and others. I believe, nothing better than this could be thought of, at least for the present. The two illustrations depicted here show the extremes that have been recorded from among several specimens collected from different localities in the region.

Habitat : Fresh water. Collected from several places in the region usually in a small number.

71. **Gomphonema augur** Ehr. (Figs. 72-73)

Habitat : Fresh water. Collected from several pools, ponds, and other large bodies of water in the region. Quite common.

72. **Gomphonema subapicatum** Fritsch & Rich (Figs. 74-80)

Habitat : Fresh water. Collected from several wet situations in the Bombay and Salsette region. In certain ponds and tanks it was found to be gregarious. Its distribution so far known in India : Punjab, whole of South-Western Zone, and N. Gujarat.

Having collected and observed this species in varying quantity for almost fifteen years from various parts of South-Western Zone of India (an area comprised of approximately 900 miles long and 100 miles broad) reaching up to parts of N. Gujarat, I am convinced that it is a distinct species. Therefore, I appreciate the diagnosis given by Fritsch & Rich (Fritsch, F. E. & Rich, F., 1929, *Trans. roy. Soc. S. Afr.* 18 : 109, f. 6 A-D). From this long tenure of work, I have found quite an amount of structural and size variations in the species which perhaps does not appear in the literature ; hence, I set it forth in the record by giving several illustrations and a table of dimensions. The forma *curta* Frit. & Rich of the said species is included within the type since I have observed all the intergrading sizes and forms from the same and different localities during different times.

Further, Hustedt has regarded such specimens of his Sunda-Expedition material as *G. gracile* Ehr. f. *turris* Hust. (Hustedt, 1938, *Arch. Hydrobiol., Suppl.* 15 : 439, t. 28, f. 14-16), calling them as tropical deviation of *G. gracile*. However, I consider them to be *G. subapicatum*, since they are so very alike in all characters. Again, I have found this species to be rather independent of *G. gracile*, frequent and sometimes gregarious. Looking at its manifestations which I have recorded, it appears that it has probably found its expression from *G. acuminatum* Ehr. and *G. augur* Ehr. series rather than from *G. gracile*. This fact may be derived from considering the apex and apicule, organisation of striae and their punctate nature, raphe, central area, and as a rule the whole of the general plan of the valve. It is assumed that the probable line of deviation might have taken through *G. acuminatun* v. *turris*, like forms which I have described earlier and my figures 70-71 perhaps bear the testimony of the same.

I herewith give in the following table the range of dimensions recorded by previous workers and here, thus :

Author	Length	Breadth	Striae per 10 μ
Fritsch & Rich (1929) ..	77-55 μ 40-28 μ	14-12 μ 11-10 μ	10-12 10-12 f. *curta*
Abdul-Majeed (1935)	same range as given by Fritsch & Rich		
Hustedt (1938)	no dimensions given		(=*G. gracile* v. *turris* Hust.)
Gandhi (1956)	99-48 μ	15.6-12 μ	9-12
present forms	85.6 μ	15.5 μ	8-10
	72 μ	14.4 μ	12-13
	70 μ	14.5 μ	13
	67 μ	12.5 μ	11-13
	60 μ	12.6 μ	12-14
	50 μ	12.7 μ	12
	49.5 μ	13.2 μ	11-12
	44 μ	9.5-11 μ	10-13
	36 μ	9.5 μ	11-12
	30 μ	9 μ	10-12
	26 μ	8.7-9 μ	10-12
forms collected from N. Gujarat area	48-62 μ	10-12.5 μ	9-11

73. **Gomphonema subapicatum** v. **okamurae** (Skv.) emend. (Fig. 81)

Skvortzow, B. W., 1937, *Philipp. J. Sci.* 62 : 209, pl. 4, f. 13 (= *G. augur* Ehr. v. *okamurae* Skv.).

Valves 49-55 μ long and 13.7-14 μ broad, lanceolate-clavate with broad abruptly narrowed subapiculate apex and from the middle gradually attenuated base. Central area with two stigmata. Striae 9-11 in 10 μ, radial and punctate. In all other features like the above type.

Habitat : Fresh water. Collected from streams at Borivli, Andheri, Goregaon and Dahisar ponds, Powai and Vihar lakes, and other places. It was recorded usually as a stray form with the species.

This diatom strongly agrees with *G. subapicatum* Frit. & Rich rather than with *G. augur* Ehr. ; hence it is considered to be a variety of the former, and Skvortzow's nomenclature is emended.

74. **Gomphonema sphaerophorum** Ehr.

Habitat : Fresh water. Collected from several wet situations from the region of Bombay and Salsette. A common type.

75. **Gomphonema subtile** Ehr. v. **malayensis** Hust. (Fig. 82)

Hustedt, 1942, *Int. Rev. Ges. Hydrobiol. Hydrogr.* 42 (1/3) : 119, f. 258-260.

Valves 45-50 μ long and 8.5-9 μ broad, lanceolate-clavate with only slightly produced, narrowly capitate rounded apex and gradually attenuated base. Raphe thin and straight. Axial area narrow, linear; central area small, very slightly unilaterally expanded with an isolated stigma on the other side. Striae 9-10 in 10 μ, radial and coarsely lineate.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, ponds at Dahisar, Goregaon, and Andheri. Mostly recorded as a stray form.

76. **Gomphonema parvulum** Kütz. (Figs. 83, 120)

Habitat : Fresh water and rarely somewhat brackish water. A widely distributed diatom. Common.

The two illustrations given show much deviation among themselves in the outline. The figure 120 is typical of the type and 83 is a variant but it agrees well with Cleve-Euler's fig. 1269 a, and Berg's illustration (Berg, Å., 1953, *Bot. Not.* 1 : 63, f. 4).

77. **Gomphonema parvulum** v. **subellipticum** Cl.

Habitat : Fresh water. Collected from several wet situations but usually in small numbers along with the type.

78. **Gomphonema parvulum** v. **micropus** (Kütz.) Cl.

Habitat : Fresh water. Collected from several pools, ponds, tanks, and other wet situations. Fairly common.

79. **Gomphonema parvulum** v. **lagenula** (Grun.) Hust. (Fig. 110)

Hustedt, 1930, Bacil. 373 ; 1949, *Expl. Parc. Nat.-Albert Miss. H. Damas* 1935-36, 8 : 119, t. 11, f. 8-10.

Valves 26-30.6 μ long and 7.2 μ broad, lanceolate-clavate with constricted subcapitate apex and slightly produced base. Raphe thin and straight. Axial area narrow, linear; central area somewhat unilateral with an isolated stigma on the opposite side. Striae about 14 in 10 μ, radial.

Habitat : Fresh water. Collected from streams at Borivli and various ponds, puddles, and pools in the region. It occurred usually with the type but in small numbers. Fairly common.

80. **Gomphonema angustatum** (Kütz.) Rabh. v. **producta** Grun. f. **indica** f. nov. (Fig. 84)

Valvae 30-32 μ longae atque 6.5 μ latae, lineari-clavatae, apice constricto, breviter elongato et rotundato, basi constricta capitata. Raphe tenuis et recta. Area axialis angusta ; area centralis parva ac unilateraliter dilatata, stigmate unico in latere opposito. Striae circiter 10-11 in 10 μ, aliquantum radiales atque indistincte punctate. Typus lectus a

H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR. —97.

Valves 30-32 μ long and 6.5 μ broad, linear-clavate, apex constricted, shortly produced and rounded ; base constricted and capitate. Raphe thin and straight. Axial area narrow ; central area small and unilaterally dilated with an isolated stigma on the opposite side. Striae about 10-11 in 10 μ, slightly radial and indistinctly punctate.

Habitat: Fresh water. Collected from streams at Borivli and Kanheri caves in a small number.

This diatom agrees with *C. angustatum* Kütz. (Schmidt, A., 1874-1944, Atlas Diat. t. 234, f. 34-36) and *G. angustatum* (Kütz.) Rabh. v. *producta* Grun. (Hustedt, 1930, Bacil. 373, f. 693) in the outline, axial and central areas, and the organisation of the striae. However, it differs in having shortly produced apex and rather capitate base ; hence it is considered to be a new form.

81. **Gomphonema martini** Fricke (Fig. 85)

Schmidt, A., 1874-1944, Atlas Diat. t. 238, f. 22-25, particularly f. 24 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 181, f. 1275 c-f (=v. *genuinum* A. Cl.).

Valves 80-97 μ long and 14-16 μ broad, narrowly lanceolate-clavate, inflated in the middle with apex acutely cuneate and base gradually attenuated. Raphe somewhat thick and straight. Axial area narrow, linear ; central area fairly large, unilateral with an isolated stigma on the opposite side. Striae about 7.5-10 in 10 μ, middle 1-2 striae are abbreviated, radial and indistinctly punctate or lineolate.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, and Powai lake, usually in a small number.

This species agrees well with the type in all respects except that from this locality larger specimens have been recorded.

82. **Gomphonema montanum** Schum. (Fig. 86)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 182, f. 1276 l-n (=v. *genuinum* Mayer) ; Schmidt, A., 1874-1944, Atlas Diat. t. 238, f. 1-11, particularly f. 1, 2, 8 (=*G. subclavatum* Grun. v. *montana* Schum.) ; Hustedt, 1930, Bacil. 375, f. 708 (=*G. longiceps* Ehr. v. *montana* (Schum.) Cl. f. *suecica* Grun.).

Valves 38.7-50 μ long and 7-7.5 μ broad, linear-clavate with undulate sides, apex broadly produced-wedge-shaped and from the middle narrowed gradually attenuated at the base. Raphe thick with part in the centre slightly unilaterally inclined. Axial area narrow, linear ; central area large, somewhat quadrate, unilaterally expanded with an isolated stigma on the opposite side. Striae 8-10 in 10 μ, slightly radial and indistinctly punctate, 1-middle striae very short.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, and Powai lake, in a good number. Elsewhere in the locality it occurred as a stray form.

83. **Gomphonema montanum** v. **acuminatum** Mayer (Figs. 100-101)

Valves 39.6-53 μ long and 12.3-12.6 μ broad, striae about 9-10 in 10 μ.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Stray specimens also were obtained from other larger bodies of water.

Skvortzow has described almost identical forms as *G. acuminatum* v. *sinica* Skv. (Skvortzow, B. W., 1935, *Philipp. J. Sci.* 57 : 474, pl. 3, f. 10-11) from Poyang lake material, which I include here.

84. **Gomphonema aequatoriale** Hust. (Figs. 87, 102)

Hustedt, 1949, *Expl. Parc Nat. Albert, Miss. H. Damas* (1935-36), 8 : 119, t. 10, f. 6-8.

Valves 48.6-80 μ long and 10.8-15 μ broad, sublinear-clavate with broad subtruncate-rounded apex and gradually attenuated base, may be sometimes concave. Raphe thick with central part slightly unilaterally bent. Axial area moderately linear ; central area large, somewhat unilaterally expanded with an isolated stigma on the opposite side. Striae 8-10 rarely up to 12 in 10 μ, clearly lineate, radial and somewhat closely set at the ends.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, Powai, Vihar, and Tansa lakes, rather frequent. Stray specimens also were recorded from ponds at several places.

This species appears to be closely related to *G. subclavatum* Grun.

85. **Gomphonema clavatoides** sp. nov. (Figs. 88-89, 103)

Valvae 26.2-36 μ longae atque 7.2-8.7 μ latae, late clavatae, apice plus minus late rotundato, basi gradatim attenuata vel raro subcapitata. Raphe tenuis et recta. Area axialis angusta, sublinearis ; area centralis plus minus ampla, unilateraliter dilatata, stigmate unico in latere opposito. Striae 6-8 in 10 μ, crasse lineatae atque aliquantum radiales. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario auctoris sub numero BOM-BOR.—99-102.

Valves 26.2-36 μ long and 7.2-8.7 μ broad, broadly clavate with more or less broadly rounded apex and gradually attenuated to rarely subcapitate base. Raphe thin and straight. Axial area narrow, sublinear ; central area more or less large, unilaterally dilated with an isolated stigma on the opposite side. Striae 6-8 in 10 μ, coarsely lineate and slightly radial.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, in good number. It is also known from Kolhapur—Rankala tank, and Katyani hills and Ahmedabad—Chandola lake.

This species does not agree with any of the similar looking forms in the literature, hence it is considered to be a new species.

86. **Gomphonema clavatoides** v. **valida** v. nov. (Fig. 104)

Valvae 37.8-40 μ longae atque 6.4-6.5 μ latae, lanceolato-clavatae, apice acute cuneato, ad basim gradatim attenuatae. Raphe aliquantum crassa et recta. Striae 7-8 in 10 μ, crasse lineatae atque aliquantum radiales. Caetera ut in typo. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—102.

Valves 37.8-40 μ long and 6.4-6.5 μ broad, lanceolate-clavate with acutely cuneate apex and gradually attenuated base. Raphe somewhat thick and straight. Striae 7-8 in 10 μ, coarsely lineate and slightly radial. In all other characters like the type.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake along with the type, as stray specimens.

This diatom differs from the above type in having acutely cuneate apex, slimmer valves and more attenuated base. It is therefore considered to be a new variety.

87. **Gomphonema lanceolatum** Ehr. (Figs. 105-107)

Habitat : Fresh water. Collected from several wet situations in the region, as a common and frequent form.

Some of the forms recorded from Bombay and Salsette region were found to be comparatively broader than the type described in the literature.

88. **Gomphonema lanceolatum** v. **insignis** (Greg.) Cl.

Habitat : Fresh water. Collected from streams at Borivli and Powai and Vihar lakes as a common form, but elsewhere seen as scarce.

89. **Gomphonema magnifica** sp. nov. (Fig. 108)

Valvae 80-90 μ longae atque 18-19.8 μ latae, lanceolato-clavatae, apicibus acute rotundatis, basi interdum concava. Raphe crassa et recta. Area axialis angusta, linearis ; area centralis parva, aliquantum unilateralis stigmate unico in latere opposito. Striae 6.5-8 in 10 μ, paululum radiales, distincte punctatae, punctis circiter 13-15 in 10 μ, singulae striae mediae remote evolutae. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 1944, 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—106.

Valves 80-90 μ long and 18-19.8 μ broad, lanceolate-clavate with acutely rounded apices, the base sometimes concave. Raphe thick and straight. Axial area narrow, linear ; central area small, slightly unilateral with an isolated stigma on the opposite side. Striae, 6.5-8 in 10 μ, very slightly radial, distinctly punctate, puncta about 13-15 in 10 μ, single middle striae distantly formed.

Habitat : Fresh water. Collected from streams at Borivli and Powai and Vihar lakes as a common form. From other bodies of water it is recorded to be very stray.

This species agrees with *G. lanceolatum* Ehr. in the outline, raphe, and punctate striae, but greatly differs in having much broader valves and larger size. Moreover, the striae are only slightly radial, very clearly punctate, and much fewer per 10 μ than in *G. lanceolatum.* It is therefore considered to be a different type, and as it does not agree with any other known species it is regarded as a new species.

90. **Gomphonema magnifica** v. **rhomboida** v. nov. (Fig. 109)

Valvae 79-85 μ longae atque 19.8-20 μ latae, rhomboideo-lanceolato-clavatae, apicibus acute rotundatis, basi interdum paululum concava. Striae 6.5-7 in 10 μ vel rarius 8 in 10 μ, distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1046, et positus in herbario proprio auctoris sub numero BOM-BOR.—106.

Valves 70-85 μ long and 19.8-20 μ broad, rhomboid-lanceolate-clavate with acutely rounded ends, the base sometimes slightly concave. Striae 6.5-7 to rarely 8 in 10 μ, distinctly punctate. In all other characters like the type.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake along with the type, usually in a small number.

This diatom differs from the type in having rhomboid-lanceolate-clavate shape and more clearly marked punctate striae.

91. **Gomphonema gracile** Ehr. (Figs. 111-112)

Habitat : Fresh water. Collected from several pools, ponds, tanks, and other wet situations in the region. A common form.

The two illustrations given here suggest the range of variation that was recorded among the forms collected from the area. The figure 112 corresponds well with Schmidt's ' Atlas Diat.' t. 236, f. 16, whereas the other does with those given by Hustedt and Cleve-Euler.

92. **Gomphonema gracile** v. **naviculoides** (W. Sm.) Grun. (Figs. 113-114)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 186, f. 1281 c ; Schmidt, A., 1874-1944, Atlas Diat. t. 236, f. 18-19 (=*G.*—v. *naviculacea* W. Sm.).

Valves 49-70 μ long and 8.5-10.8 μ broad, almost isopolar, lanceolate-weakly-clavate, slightly bent with attenuated ends. Raphe thin and straight, feebly excentric. Axial area narrow, linear-lanceolate ; central area roundish and somewhat unilaterally expanded with an isolated stigma on the opposite side. Striae 12-16 in 10 μ, radial and indistinctly punctate.

Habitat : Fresh water. Collected from ponds at Andheri, Jogeshwari, Goregaon, streams at Borivli, and Powai lake, usually in a small number along with the type. Fairly distributed.

93. **Gomphonema gracile** v. **aurita** A. Br. (Fig. 115)

Schmidt, A., 1874-1944, Atlas Diat. t. 236, f. 20-24 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 186, f. 1281 i (=*G.* —v. *auritum* A. Br.).

Valves 56-59 μ long and 9.2-9.6 μ broad, lanceolate-clavate, somewhat rhomboid with acutely rounded ends. In living cells ends are often provided with gelatinous apicules. Raphe thin and straight. Axial area very narrow ; central area slightly unilaterally formed with an isolated stigma on the opposite side. Striae 13-17 in 10 μ, strongly radial and more closely set towards the ends, one middle striae quite distant than the rest.

Habitat : Fresh water. Collected from Powai and Vihar lakes in good number but elsewhere seen as very stray specimens.

94. **Gomphonema gracile** v. **lanceolata** (Kütz.) Cl. (Fig. 116-117)

Schmidt, A., 1874-1944, Atlas Diat. t. 236, f. 25-28, t. 237, f. 9-10 (=*G.*—v. *lanceolata* Kütz.) ; Hustedt, 1938, *Arch. Hydrobiol., Suppl.*, 15 : 439, t. 28, f. 11-13 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn. —IV, 186, f. 1281 m-o (=*G.* —v. *lanceolatum* (Kütz.) Cl. ?).

Valves 45-49 μ long and 9-10 μ broad, distinctly lanceolate-clavate with more acutely rounded apex than the base, sometimes feebly constricted and produced. Raphe coarse and straight. Axial area very narrow ; central area small, slightly unilateral with an isolated stigma. Striae 14-16 in 10 μ, radial and indistinctly lineolate.

Habitat : Fresh water. Collected from several wet situations in the region but usually in a small number along with the type.

The present diatoms differ from Cleve-Euler's specimens in not having clearly defined apiculate apex. Moreover, the outline here is rather more lanceolate than clavate. Hustedt's *G. gracile* v. *lanceolata* (Kütz.) Cl. (Hustedt, 1930, Bacil. 376, f. 703) differs in having more drawnout apex. However, the present specimens very closely agree with those illustrated in the 'Atlas' and recorded by Hustedt (1938).

95. **Gomphonema gracile** v. **frickei** v. nov. (Fig. 90)

Valvae 50-52 μ longae atque 11-11.2 μ latae, clavato-lanceolatae, apice constricto, distincte apiculato, basi gradatim attenuata. Raphe tenuis et recta. Area axialis angustissima ; area centralis aliquantum unilateraliter dilatata, stigmate unico in latere opposito. Striae 8-12 in 10 μ, radiales atque indistincte punctatae. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—60.

Valves 50-52 μ long and 11-11.2 μ broad, clavate-lanceolate with constricted distinctly apiculate apex and gradually attenuated base. Raphe thin and straight. Axial area very narrow, central area slightly unilaterally dilated with an isolated stigma on the opposite side. Striae 8-12 in 10 μ, radial and indistinctly punctuate.

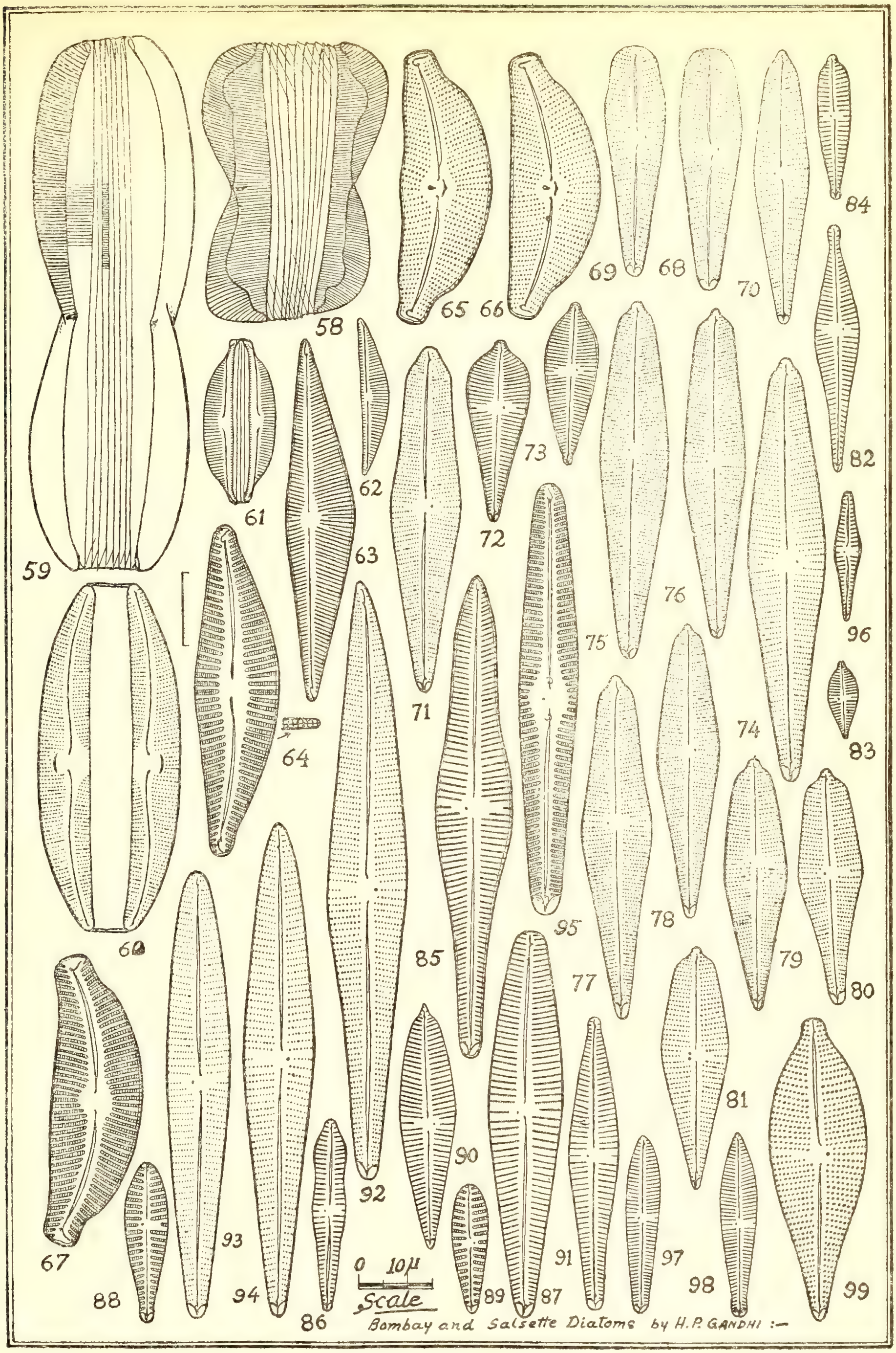
Habitat : Fresh water. Collected from Powai lake as a stray form.

This diatom more or less agrees well with " *G. gracile* v.", as given in the 'Atlas Diat.' t. 236, f. 31, in the outline and sharply pointed apiculate apex. However, the present valves are clearly clavate, i.e. the apex region is distinctly broad ; thus they differ. As the figure 31 on t. 236 of the 'Atlas' has no complete name, it has been named here and the present specimens are included under the same with the noted differences.

96. **Gomphonema gracile** v. **subcapitata** v. nov. (Fig. 91)

Valvae 50-60 μ longae atque 9-10 μ latae, lanceolato-clavatae, apice constricto subcapitato, basi aliquantum concava, attenuato-rotundata. Raphe tenuis et recta. Area axialis angustissima ; area centralis magna, unilateraliter dilatata, stigmate unico in latere opposito. Striae 8-9 in medio ac 9-13 in 10 μ in utroque apice, radiales atque indistincte punctatae. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—16.

Valves 50-60 μ long and 9-10 μ broad, lanceolate-clavate with constricted subcapitate apex and slightly concave, gradually attenuated rounded base. Raphe thin and straight. Axial area very narrow ; central area large, unilateral with an isolated stigma on the opposite side. Striae 8-9 in the middle and 9-13 in 10 μ, towards the ends, radial and indistinctly punctate.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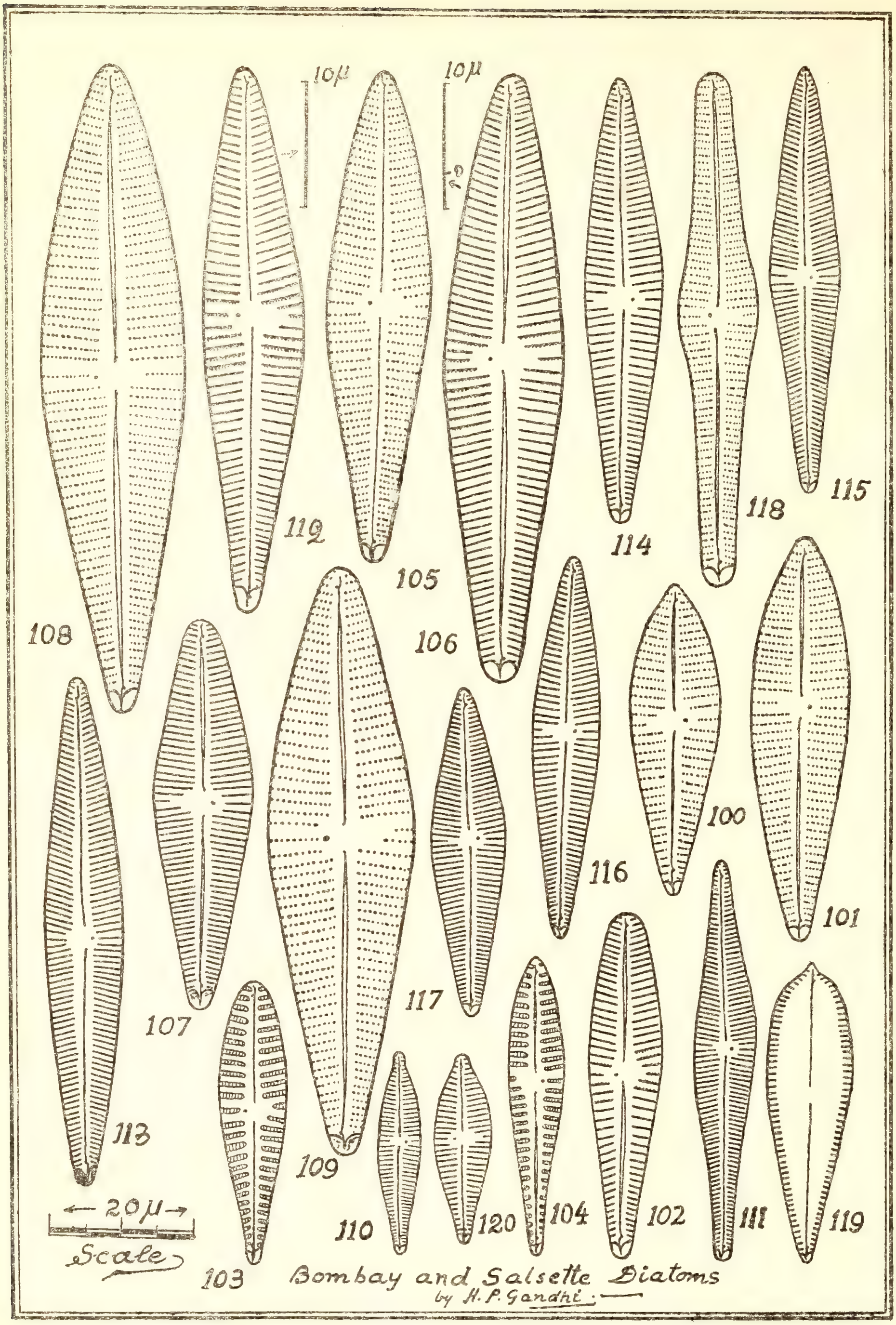
Bombay and Salsette Diatoms by H.P. GANDHI :—

FIGURES 58-99

Fig. 58. *Amphiprora alata* Kütz.; 59. *Amphiprora lata* Grev. v. *angustior* McCall.; 60. *Amphora ovalis* Kütz. v. *gracilis* (Ehr.) Cl.; 61. *Amphora acutiuscula* Kütz.; 62. *Cymbella gracilis* (Rabh.) Cl.; 63. *Cymbella yarrensis* (A. S.) Cl.; 64. *Cymbella leptoceros* (Ehr.?) Grun. v. *rostrata* Hust. f. *indica* f. nov.; 65-66. *Cymbella tumida* (Bréb.) V. H.; 67. *Cymbella powaiana* sp. nov.; 68. *Gomphonema constrictum* Ehr. v. *capitata* (Ehr.) Cl.; 69. *Gomphonema constrictum* v. *indica* v. nov.; 70-71. *Gomphonema acuminatum* Ehr. v. *turris* (Ehr.) Cl.; 72-73. *Gomphonema augur* Ehr.; 74-80. *Gomphonema subapicatum* Fritsch & Rich; 81. *Gomphonema subapicatum* v. *okamurae* (Skv.) emend.; 82. *Gomphonema subtile* Ehr. v. *malayensis* Hust.; 83. *Gomphonema parvulum* Kütz.; 84. *Gomphonema angustatum* (Kütz.) Rabh. v. *producta* Grun. f. *indica* f. nov.; 85. *Gomphonema martini* Fricke; 86. *Gomphonema montanum* Schum.; 87. *Gomphonema aequatoriale* Hust.; 88-89. *Gomphonema clavatoides* sp. nov.; 90. *Gomphonema gracile* v. *frickei* v. nov.; 91. *Gomphonema gracile* v. *subcapitata* v. nov.; 92. *Gomphonema spiculoides* v. *major* v. nov.; 93. *Gomphonema balatonis* Pant.; 94. *Gomphonema balatonis* v. *lanceolata* v. nov.; 95. *Gomphonema sumatrense* Fricke; 96. *Gomphonema undulatum* Hustedt; 97-98. *Gomphonema tenuis* sp. nov.; 99. *Gomphonema moniliforme* sp. nov.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Scale
Bombay and Salsette Diatoms
by H. P. Gandhi

FIGURES 100-120

Fig. 100-101. *Gomphonema montanum* v. *acuminatum* Mayer; 102. *Gomphonema aequatoriale* Hust.; 103. *Gomphonema clavatoides* sp. nov.; 104. *Gomphonema clavatoides* v. *valida* v. nov.; 105-107. *Gomphonema lanceolatum* Ehr.; 108. *Gomphonema magnifica* sp. nov.; 109. *Gomphonema magnifica* v. *rhomboides* v. nov.; 110. *Gomphonema parvulum* v. *lagenula* (Grun.) Hust.; 111-112. *Gomphonema gracile* Ehr.; 113-114. *Gomphonema gracile* v. *naviculoides* (W. Sm.) Grun.; 115. *Gomphonema gracile* v. *aurita* A. Br.; 116-117. *Gomphonema gracile* v. *lanceolatum* (Kütz.) Cl.; 118. *Gomphonema intricatum* v. *vibrio* (Ehr.) Cl.; 119. *Gomphonema lingulatum* Hust.; 120. *Gomphonema parvulum* Kütz.

Habitat : Fresh water. Collected from pools and ponds at Wadala in a small number along with the type. It is also recorded from the Jog falls.

This diatom agrees well with *G. gracile* Ehr. in the general outline, range of dimensions, and the nature and arrangement of the striae. However, the forms observed during different times always showed the apex slightly constricted and subcapitate ; hence such specimens are considered to be a new variety.

97. **Gomphonema spiculoides** Gandhi, nov. nom.

G. spicula Gandhi, *J. Bombay nat. Hist. Soc.* **55** : 501, f. 28, 1958 (non *G. spicula* Manguin).

Habitat : Fresh water. Collected from pools and ponds at Wadala, ponds at Andheri, Goregaon, Vile-Parle, and streams at Borivli. Fairly common.

I have to introduce here a new nomenclature for my *G. spicula*, since my esteemed friend Dr. J. W. G. Lund informed me of the same name existing in the literature. Unfortunately, I did not have the publication in which the other *G. spicula* was described, nor could I avail the same from any other source. Naturally, I approached Dr. Manguin who so kindly furnished me with the full information regarding his *G. spicula*, and I understand that my *G. spicula* is a different species altogether. I, herewith, extend my grateful thanks to both these friends for furnishing me with the valuable information.

98. **Gomphonema spiculoides** v. **major** v. nov. (Fig. 92)

Valvae 90-123 μ longae atque 12.5-16 μ latae, anguste lanceolato-clavatae, aliquantum arcuatae, apice acutissimo, ad basim gradatim attenuatae. Raphe crassa, parte centrali unilateraliter inclinata. Area axialis angustissima ; area centralis unilateraliter dilatata, stigmate unico in latere opposito. Striae 7-8 in medio ac 8-11 in 10 μ in utroque apice, radiales atque distincte punctatae, punctis 16-18 in 10 μ. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—18.

Valves 90-123 μ long and 12.5-16 μ broad, narrowly lanceolate-clavate, slightly arcuate, apex very acute, towards the base gradually attenuated. Raphe thick with central part unilaterally bent. Axial area very narrow ; central area unilaterally dilated with an isolated stigma on the opposite side. Striae 7-8 in the middle and 8-11 in 10 μ towards the ends, radial and distinctly punctate, punctae about 16-18 in 10 μ.

Habitat : Fresh water. Collected from ponds at Wadala in good number, but stray specimens also were collected from ponds at Goregaon, Andheri, Vile-Parle, and Borivli streams. Fairly distributed in the region.

This diatom agrees well with *G. spiculoides* Gandhi, collected here and from Kolhapur and Jog falls, in the shape, raphe, and the organisation of the striae. However, these forms are very large with comparatively very few striae per 10 μ. Unfortunately, I have so far not come across any such intergrading specimens which might connect these two extreme ranges of dimensions. I, therefore, regard the present specimens to be a new variety of *G. spiculoides*, till the other intergrading individuals are discovered.

99. **Gomphonema intricatum** Kütz.

Habitat : Fresh water. Collected from ponds at Goregaon, Dahisar, Sion, streams at Borivli, and Powai, Vihar, and Tansa lakes. Fairly common.

100. **Gomphonema intricatum** v. **vibrio** (Ehr.) Cl. (Fig. 118)

Habitat : Fresh water. Collected from pools, ponds, and tanks around Andheri, Goregaon, Vile-Parle, and other wet situations in the region, usually in a small number.

101. **Gomphonema balatonis** Pant. (Fig. 93)

Pantocsek, J., 1902, *Res. Wiss. Erf. Balat.* 2 (2) : 64, t. 7, f. 164.

Valves 86-90 μ long and 12-12.6 μ broad, narrowly lanceolate-clavate with rounded ends without constrictions. Raphe thick and straight, terminal fissures distinct. Axial area narrow, linear ; central area slightly unilaterally enlarged with an isolated stigma on the opposite side. Striae 6-7 in 10 μ in the middle up to 8.5 towards the ends, slightly radial, fine but clearly punctate, punctae about 13-15 in 10 μ.

Habitat : Fresh water. Collected from Powai and Vihar lakes in a small number. It was also collected from Someshwar tank at Dharwar as a stray form.

This species agrees well with the type described by Pantocsek, except that the local forms were found to be somewhat of larger size. Cleve-Euler regards the same as *G. lanceolatum* Ehr. v. *affine* (Kütz.) A. Cl. (Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 185, f. 1280 g-p), but the illustrations given do not agree well either with Pantocsek's or the present forms. Moreover, the striae do not appear to be very closely set towards the apices as are being indicated by Cleve-Euler (striae at the ends shown to be around 11-13 in 10 μ). I, therefore, consider *G. balatonis* Pant. to be different from *G. lanceolatum* v. *affine*, of Cleve-Euler.

Further, Hustedt has described a diatom as *G. dubravicense* Pant.

(Hustedt. 1938, *Arch. Hydrobiol., Suppl.* 15 : 437, t. 28, f. 1) which agrees with the present form in all respects except that it has two stigmas in the central area. While referring to Pantocsek's original paper (Pantocsek, J., 1905, Beit. z. Kenn. foss. Bac.—III, 54, t. 20, f. 294, 296), illustrations given in the ' Atlas Diat.' t. 238, f. 32-34, and by Cleve-Euler (Cleve-Euler, op. cit. IV, 190, f. 1286 a-b), it appears that *G. dubravicense* Pant. is more or less tumid in the middle with axial and central areas comparatively large and the central area has more than two stigmas in one or more rows situated on one or both sides of the central nodule. Evidently, Hustedt's *G. dubravicense* seems to be different from that of Pantocsek's. However, I am presently not quite sure if it could be referable to *G. balatonis* or otherwise, since my own material has been too little to allow more detailed study.

102. **Gomphonema balatonis** Pant. v. **lanceolata** v. nov. (Fig. 94)

Valvae 100-108 μ longae atque 14-14.4 μ latae, anguste lanceolato-clavatae, apice acute cuneato, basi gradatim attenuata. Striae 6-8 in 10 μ, aliquantum radiales atque distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—108.

Valves 100-108 μ long and 14-14.4 μ broad, narrowly lanceolate-clavate with acutely cuneate apex and gradually attenuated base. Striae 6-8 in 10 μ, slightly radial and distinctly punctate. In all other characters like the type.

Habitat : Fresh water. Collected from Powai lake along with the type in a small number. A few specimens also were available from streams at Borivli. A rare type.

This diatom differs from the type in having acutely cuneate apex and somewhat more distinctly punctate striae. It also bears some resemblance with *G. hungaricum* Pant. (Pantocsek, J., 1905, Beit. z. Kenn. foss. Bac.—III, 54, t. 2, f. 28), but the present form differs in having more narrowly cuneate apex and only a single shortened striae in the middle part. However, it may be stated that further observations are necessary regarding this diatom to draw any conclusions.

103. **Gomphonema sumatrense** Fricke (Fig. 95)

Schmidt, A., 1874-1944, Atlas Diat. t. 248, f. 2-3.

Valves 87.7-94 μ long and 12-12.4 μ broad, narrowly-lanceolate-clavate with broadly rounded ends. Raphe thick and straight with part in the central nodule transversely comma-shaped and terminal fissures distinct, bayonet-shaped. Axial area narrowly lanceolate, gradually widened in the middle to form a wide, more or less elliptical central area, stigma formed on one side. Striae 7-8.5 in 10 μ, coarsely lineate, radial, lineations about 18-20 in 10 μ.

Habitat : Fresh water. Collected from ponds at Goregaon, Andheri, Vile-Parle, streams at Vajreshwari, Powai and Vihar lakes. It mostly occurred as a stray form.

104. **Gomphonema undulatum** Hustedt (Fig. 96)

Hustedt, 1936, *Arch. Hydrobiol., Suppl.* 14 : 166, t. 5, f. 34 ; 1938, *ibid.*, 15 : 441, t. 28, f. 2-8.

Valves 25-35 μ long and 5.2-5.8 μ broad, lanceolate-clavate with sides between the middle and ends somewhat concave, apex more broad than the base. Raphe coarse and clearly undulate with central part unilaterally bent. Axial area very narrow ; central area quite large and unilateral with an isolated stigma on the opposite side. Striae 10-11 in 10 μ, coarse, radial, indistinctly punctate and the middle striae very much shortened.

Habitat : Fresh water. Collected from streams at Borivli, Chembur hills, Powai and Vihar lakes, usually in a small number.

105. **Gomphonema tenuis** sp. nov. (Figs. 97-98)

Valvae 30-37.5 μ longae atque 6.4-7.4 μ latae, clavato-lanceolatae, apice acuto-cuneato, basi gradatim attenuata, late rotundata, aliquando producta vel producto-subcapitata. Raphe tenuis et recta. Area axialis angustissima ; area centralis magna, unilateraliter dilatata, stigmate unico in latere opposito. Striae 13-15 in 10 μ, radiales, subtiles, media vero striae valde abbreviata. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—107.

Valves 30-37.5 μ long and 6.4-7.4 μ broad, clavate-lanceolate with acutely cuneate apex and gradually attenuated broadly rounded base, base sometimes produced to produced-subcapitate. Raphe thin and straight. Axial area very narrow ; central area large, unilaterally dilated with an isolated stigma on the opposite side. Striae 13-15 in 10 μ, radial, quite fine and one middle striae much abbreviated.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, Powai lake, in a good number mixed up in vegetable dead matter. It was also collected from Kolhapur-Katyani hill streams, and some pools along roadsides.

This species does not agree with any of the known types of similar shape ; hence it is considered to be a new species.

106. **Gomphonema moniliforme** sp. nov. (Fig. 99)

Valvae 56-52 μ longae atque 19-20 μ latae, late clavatae, apice constricto, producto-subtruncato, basi aliquantum concava ad latera ac attenuata. Raphe crassa et recta, parte centrali unilateraliter inclinata in nodulo centrali, fissuris terminalibus distinctis. Area axialis angusta, linearis ; area centralis angusta, unilateraliter dilatata, stigmate unico in latere opposito. Striae 7.5-8 in 10 μ, aliquantum radiales, crasse punctatae, punctis circiter 11-13 in 10 μ. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—110.

Valves 56-62 μ long and 19-20 μ broad, broadly-clavate, apex constricted, produced-subtruncate ; base with slightly concave sides and attenuated. Raphe thick with part in the central nodule unilaterally bent and terminal fissures distinct. Axial area narrow, linear ; central area narrow unilaterally dilated with an isolated stigma on the opposite side. Striae 7.5-8 in 10 μ, slightly radial, coarsely punctate and puncta about 11-13 in 10 μ.

Habitat : Fresh water. Collected from Powai lake in a small number.

This diatom is quite distinctive and does not agree with any other type, hence it is considered to be a new species.

107. **Gomphonema olivaceum** (Lyngb.) Kütz.

Habitat : Fresh water. Collected from streams at Borivli, Powai, Vihar, and Tansa lakes, and several other large bodies of water in region. A common form.

108. **Gomphonema lingulatum** Hust. (Fig. 119)

Hustedt, 1927, *Arch. Hydrobiol.* 18 : 166, t. 5, f. 5 ; Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 52, pl. 13, f. 6-7 ; 1937b, *ibid.* 61 : 285, pl. 3, f. 13 ; Hustedt, 1938, *Arch. Hydrobiol., Suppl.* 15 : 443, t. 27, f. 1.

Valves 30-42 μ long and 10-12 μ broad, clavate with shortly apiculate apex and gradually attenuated base. Raphe thin and straight. Axial area very broad ; central area not defined. Stigma absent. Striae 14-15 in 10 μ, radial, short and marginal.

Habitat : Fresh water. Collected from Powai and Vihar lakes in a small number.

SUMMARY

This paper deals with the diatom genera *Pinnularia*, *Amphiprora*, *Amphora*, *Cymbella*, and *Gomphonema*, collected from the year 1945 to 1958, from the region of Bombay and Salsette. Here, in all 108 diatoms are recorded of which 53 are new records for India and eight species, twelve varieties, and three forms are considered to be new to science.

ACKNOWLEDGEMENT

The author wishes to record his grateful thanks to Prof. (Mrs.) E. A. Gonzalves for early suggestion of the problem, to Rev. Father F. Braganza and Rev. Father H. Santapau for correcting the Latin diagnoses of the new diatoms described in this paper. He is further indebted to the latter for the information concerning valid publication of new taxa.

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——— (1937d) : Diatoms from Olhan Gate of Baikal Lake, Siberia, ibid. **62** : 293-377.

——— (1938a) : Diatoms from a peaty bog in Lianchiho River Valley, Eastern Siberia, ibid., **66** : 161-82.

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Critical Notes on the Orchidaceae of Bombay State

II. *PLATANTHERA* L. C. RICH. & *PERISTYLUS* BL.

BY

H. SANTAPAU, S.J., F.N.I. AND Z. KAPADIA, PH.D.

(*With four plates*)

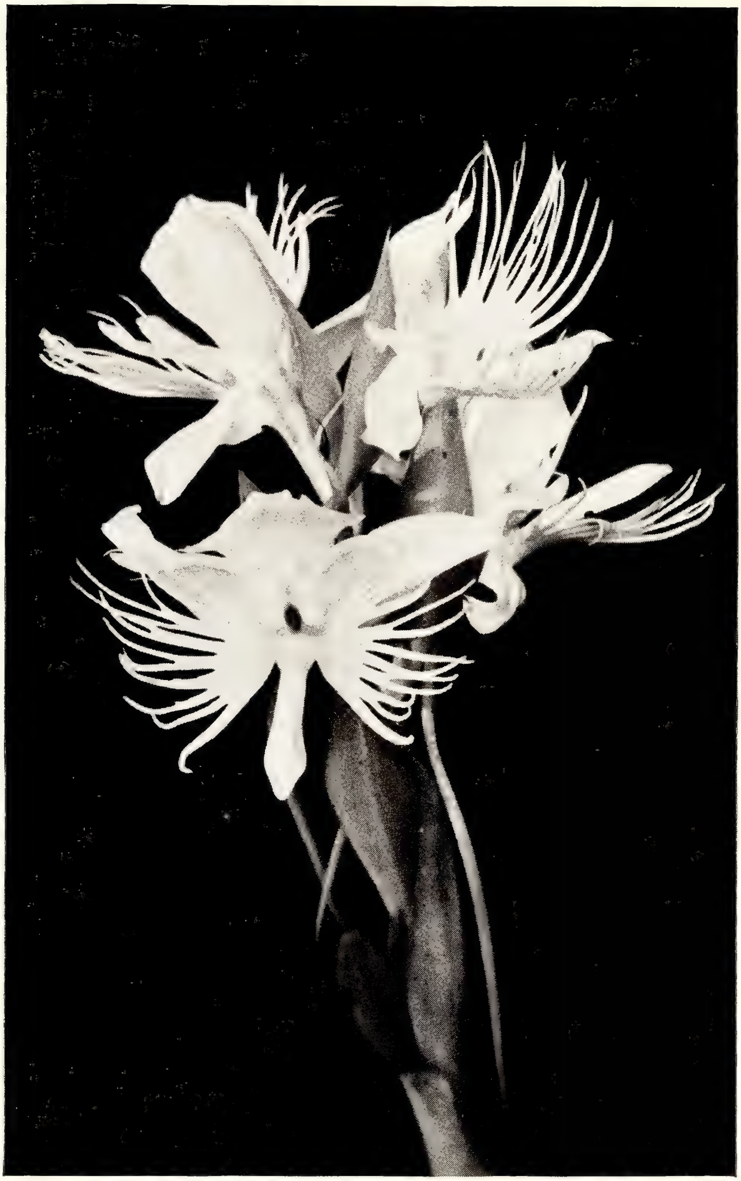
[*Continued from Vol.* **56** (2): 203]

These two genera are treated in this paper together on account of their close relationships. The genera *Platanthera* L. C. Rich. and *Peristylus* Bl. are in fact so closely allied among themselves and with the genus *Habenaria* that many of the older botanists treated the three genera as one, *Habenaria*, the other plants being merely distinguished as sections of the same genus. This is the case, for instance, in Bentham and Hooker's GENERA PLANTARUM and in Hooker's FLORA OF BRITISH INDIA. Modern authors are somewhat divided on the subject; Holttum (1953) retains the whole group under *Habenaria*; on the other hand, J. J. Smith (1905) and Summerhayes (1951) split the group into distinct genera. Cooke in his FLORA OF THE PRESIDENCY OF BOMBAY, and Blatter and McCann in their REVISION OF THE FLORA OF THE BOMBAY PRESIDENCY keep *Platanthera* and *Peristylus* independent from *Habenaria*. In the following pages we treat these two genera as closely allied to but independent from *Habenaria*.

Our Bombay genera may be distinguished by the following key:

1. Flowers about 7.5 cm. across, greenish white; stigmatic surfaces flat, almost confluent .. ***Platanthera***
1. Flowers under 3 cm. across, white or yellow; stigmatic surfaces not flat, and separate:
    2. Ovary and capsule more or less erect, and parallel to the peduncle, not spreading at an angle to it; stigmatic surfaces in the form of small swellings on the edge of the lip .. .. .. ***Peristylus***
    2. Ovary and capsule widely spreading at an angle to the peduncle; stigmatic lobes standing out as stalked appendages .. ***Habenaria***

NOTE: In the following pages, under the heading 'Occurrence in Bombay State', we list plants from Bombay State as understood after



Platanthera susannæ Lindl.

Whole inflorescence of plant collected from Khandala and grown in Bombay.

Photo : H. Santapau

Independence but prior to the Reorganisation of the States, that is to say we include plants from N. Kanara districts that were formerly part of Bombay State. With but few exceptions, the specimens mentioned for the various parts of Bombay are preserved in Blatter Herbarium, St. Xavier's College, Bombay.

PLATANTHERA L. C. Rich.

PLATANTHERA L. C. Rich. in Mem. Mus. Paris 4: 48, 1818; Pfitzer in Engler & Prantl, Natürl. Pflanzenfam. 2 (6): 92, 1889 (excl. syn. *Peristylus* Bl.); J. J. Smith in Fl. Buitenz. 6: 26, 1905; Slechter, Orchid. 62, 1927. *Habenaria* Benth. & Hook. Gen. Pl. 3: 624, 1863; Hook. f. Fl. Brit. India 6: 131, 1890; Duthie in Ann. R. Bot. Gard. Calcutta 9 (2): 174, 1906; Holttum, Rev. Fl. Malaya 1: 79, 1953 (omnes pro parte). *Lysias* Salisb. in Trans. Hortic. Soc. 1: 288, 1812, nom. nud. (See Plates VII & VIII).

The generic name, *Platanthera*, is made up of two Greek words, *Platys*=flat and *Anthera*=anthers. The genus is distributed in the Northern Temperate Zone of the World, particularly in North America; a few species occur in Europe and in tropical Asia.

Pfitzer has divided the genus *Platanthera* into two sections, 1. *Filicornes*, with a thin and long spur, and 2. *Crassicornes*, with a stout and short spur. In accordance with Art. 22 of the Code, the first section (that includes the type species) should be called *Platanthera* sect. *Platanthera*. Our Bombay species belong to this first section.

Platanthera susannae (Linn.) Lindl. Gen. Sp. Orch. 295, 1835; Wight, Icon. t. 920; Dalz. & Gibs. Bombay Fl. 261, 1861; J. J. Smith 27, f. 9; Cooke 2: 713, 1907; Fischer in Gamble, Fl. Madras 1475, 1923; Blatt. & McCann in Journ. Bombay Nat. Hist. Soc. 36: 736, 1932; Santapau in Rec. Bot. Surv. India 16 (1): 305, 1953. *Orchis susannae* Linn. Sp. Pl. 939, 1753; Lour. Fl. Coch. 522, 1790. *Orchis gigantea* Smith, Exot. Bot. 2: 79, t. 100, 1805. *Habenaria gigantea* D. Don, Prodr. Fl. Nepal. 24, 1825; Graham, Cat. Bombay Pl. 201, 1839. *Habenaria susannae* (Linn.) R. Brown ex Sprengel, Syst. Veg. 3: 622, 1826; Hook. f. Fl. Brit. India 6: 137, 1890; Prain, Bengal Pl. 1030, 1903; Duthie, loc. cit. 178, t. 128, & Fl. Upp. Gang. Pl. 3: 222, 1920; Gammie in Journ. Bombay Nat. Hist. Soc. 21: t. 11, 1911; Haines, Bot. Bihar Or. 1155, 1924; Merrill in Trans. Amer. Phil. Soc. n.s. 24: 121, 1935; Holttum 81, f. 13.

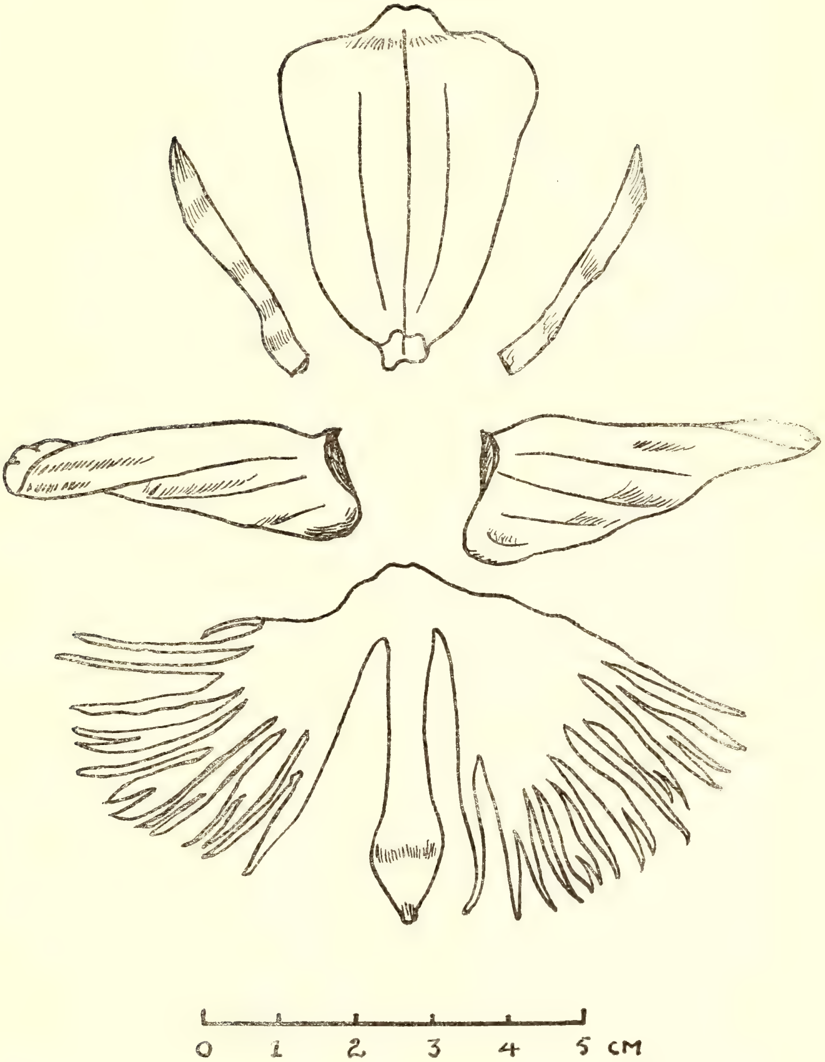
Stout terrestrial herbs, 60-120 cm. high. *Tubers* 2, ellipsoid or ovoid. *Leaves* 5-18×2-7 cm., ovate-oblong or oblong-lanceolate, acute, often with a sharp black apex, entire, glabrous, deep green above, paler beneath; sheaths veined, the veins decurrent from the lamina; midnerve prominent beneath, with 8-10 fainter side-nerves; margins faintly yellowish. *Inflorescence* terminal, in 2-6-flowered racemes, 16-20 cm. long. *Flowers* 6×7.5 cm., white faintly tinged with green, bracteate, shortly pedicellate, strongly perfumed, especially when freshly opened. *Bracts* 6-10×1.5-2 cm., longer than and ensheathing the ovary, oblong-lanceolate, subacuminate, often sharply pointed, entire, several-nerved. *Sepals* unequal, white, faintly suffused with green, entire, 5-nerved; dorsal sepal 4.6×3.4 cm., revolute on the margins, subconcave, obovate-elliptic, obtuse; lateral sepals 4.4×1.8 cm., spreading lightly backwards, somewhat ascending, revolute on the margins, obliquely subquadrately oblong, acute. *Petals* 3.4×0.4 cm., white, narrowly linear-oblong, obliquely curving along the lower margins to an acute apex. *Lip* 4.7×9 cm., white, fan-shaped in outline, fimbriately dissected into 10-16 thin, narrow, often bipartite, 8-26×0.5-1 mm., narrowly linear-filiform segments; midlobe 3.8×0.9 cm., recurved at the margins, elliptic, slightly dilated beyond the middle, obtuse. *Spur* 8-11.5 cm. long, about 3-5 mm. in diam., pale green, obtuse; mouth broad. *Column* 7.1×1.2 mm., white, oblong, truncate-retuse above. *Anther* cells 0.4 cm. long, curved, divergent; pollinia 2, each 6×2 mm., yellow, narrowly falcate with a 6 mm. long, thin caudicle and a small, shiny, ovate-elliptic gland. *Stigmatic* surfaces 2, almost touching, 5×5 mm., just below the rostellum, white, squarely oblong with rounded ends, flat. *Ovary* 4.3×0.7 cm., strongly ribbed, green with 4 yellowish ridges. *Capsule* 4.5×1.5 cm., ellipsoid, strongly ribbed; beak 7 mm. long.

Flowering: September to October. *Fruiting:* October to December.

Occurrence in Bombay State: DANGS: Waghai, *Kapadia* s.n.; Susarda, *Kapadia* 711. KONKAN: Bombay, cultivated, *Santapau* 1578; *Kapadia* 726; Matheran, *Cooke*. W. GHATS: Igatpuri, *Kapadia* s.n.; Khandala, *Blatter* 25953; *Santapau* 775, 1101, 2672, 2818-2820, 5010, 11156; *Kapadia* 627-628; Lonavla, *D. K. Patel*. DECCAN: Lohagad, *Blatter* 27522; Dapoli, *Acland* 1173. N. KANARA: Belgaum, *Ritchie*; Yellapur, *Bell* 3121; Castle Rock, *Gammie, Sedgwick*.

Distribution in India: Most of the hilly parts of India from the lower Himalayan ranges to the south of the country. *World:* India, Burma, China, Java, and throughout Malaysia.

Critical Notes: In cultivated specimens the flowers have been noted to appear somewhat earlier and to be larger than in wild specimens. In the field this beautiful orchid grows usually on sloping ground at the edges of forest, usually in places rich in humus. The plant suffers much persecution from humans, who find the flowers



Platanthera susannae Lindl. Dissection of the calyx and corolla.

very attractive, and from wild pigs, who uproot many plants for the sake of the apparently very tasty tubers.

In our floras the binomial *Habenaria susannae* is usually attributed to R. Brown; but according to Merrill this is not correct, for Brown did not make the actual combination as required by Art. 32, paragraph 2 of the Code; Merrill gives the combination as *H. susannae* R. Br. ex Sprengel, Syst. Veg. 3: 622, 1826.

Cultivation: This beautiful orchid does deserve a place in our gardens, and it is one of the easiest plants to grow under artificial conditions. In St. Xavier's College garden a specimen has been kept growing and flowering regularly for over 15 years. In the first instance the plant was collected from Khandala, and planted in a flower-pot; after flowering and fruiting, the plant was left in the flower-pot without watering until the following season's monsoon. Flowers are showy, the largest among our Bombay wild orchids, and about the most sweetly and strongly scented among our wild flowers. The photograph appearing at the beginning of this paper was taken from a plant grown in Bombay from a Khandala specimen.

PERISTYLUS BL.

PERISTYLUS Bl. Bijdr. 404, t. 30, 1825; Endl. Gen. Pl. 209, 1837; J. J. Smith, Fl. Buitenz. 6: 30, 1906; Cooke 710; Santapau in Rec. Bot. Surv. India 16 (1): 305, 1953. *Habenaria* sect. *Peristylus* Bth. & Hk. Gen. Pl. 3: 624, 1883; Hook. f. Fl. Brit. India 6: 131, 1890; King & Pant. in Ann. R. Bot. Gard. Calcutta 8: 305, 1898; Duthie, ibid. 9 (2): 174, 1906. *Platanthera* Pfitzer in Engl. & Prantl, Natürl. Pflanzenfam. 2 (6): 92, 1888 pro parte.

The generic name, *Peristylus*, is derived from the Greek words *Peri* = around and *Stylus* = column, probably referring to the shape of the column, which is in the form of a protuberance from the apical portion of the ovary. In Bombay State the plants belonging to this genus are among the least showy of our wild orchids; flowers are usually in compact racemes or spikes, and individually they are small and inconspicuous; the plants, however, are typical in their appearance and in their habitat, i.e. the surroundings in which they grow.

Many modern orchidologists favour including *Peristylus* under *Habenaria* Willd.; Pfitzer, loc. cit., separates it from *Habenaria* but places it under *Platanthera*. We keep it separate from both, following among others J. J. Smith, for the reason that *Peristylus* forms a natural and clearly distinct group in our native orchids. There are about 80 species of *Peristylus* distributed in the warmer regions of the Old World.

KEY TO THE SPECIES OF *PERISTYLUS* OF BOMBAY

1. Spur as long as or longer than sepals, linear, subclavate:
  2. Leaves sessile, narrowly lanceolate; lateral sepals linear; lateral lobes of lip subulate, or narrowly linear-oblong, spreading, about twice as long as the midlobe; spur scarcely clavate at apex .. .. *densus*
  2. Leaves tapered at base, broadly obovate-elliptic; lateral sepals broad; lobes of lip subequal, linear oblong, rounded; spur inflated at apex *stocksii*
1. Spur much shorter than sepals, saccate, globose:
  3. Leaves scattered or subimbricate on stem .. *spiralis*
  3. Leaves clustered about middle of stem:
    4. Petals white; lip shorter than the broad sepals, entire or scarcely 3-lobed, lobes very small, entire, rounded .. *plantagineus*
    4. Petals yellow or yellowish-green; lip about as long as sepals, distinctly 3-fid:
      5. Spikes dense; lateral sepals mucronate at the back a little below apex .. *goodyeroides*
      5. Spikes lax; lateral sepals not mucronate .. *lawii*

1. **Peristylus densus** (Lindl.) Santapau & Kapadia, comb. nov. *Coeloglossum densum* Lindl. Gen. Sp. Orch. 302, 1835. *Gymnadenia ? tenuis* Lindl. in Wall. Cat. n. 7057, 1832, nom. nud. *Habenaria peristyloides* Wight, Icon. t. 1702, 1851. *Platanthera stenostachya* Lindl. in Hook. J. Bot. 7: 37, 1855. *Habenaria stenostachya* Benth. Fl. Hongk. 362, 1861; Hook. f. Fl. Brit. India 6: 156. *Peristylus stenostachyus* (Lindl.) Kränz. Orchid. Gen. Spec. 1: 502, 1898; Fischer in Gamble, Fl. Pres. Madras 1474, 1928; Blatt. & McC. in Journ. Bombay Nat. Hist. Soc. 35: 734, 1932. *P. xanthochlorus* Blatt. & McC. loc. cit. 733, 1932. (See Plate IX, A-B)

Herbs 12-35 cm. tall. *Tuber* 1, small, globular. *Leaves* grouped on the basal third of the stem, green or yellowish-green, sheathing, 2-7×0.5-2 cm., lanceolate, oblong-lanceolate or linear lanceolate, acute or obtuse, mucronulate, entire, minutely papillate; midnerve prominent below with 3-5 lateral fainter nerves. *Inflorescence* in lax or dense spikes 7-21 cm. long; peduncle slender, up to 3 mm. thick, short, terete; bracts distantly or closely arranged, subopposite to imbricate, lanceolate, entire, minutely papillate, subacuminate; the margins paler. *Flowers* yellowish-white to greenish-yellow, subsecund, bracteate, sessile.

Bracts unequal, the lower equalling or slightly longer than the flowers, the upper ones shorter, 7-15×3-5 mm., acute or acuminate. *Sepals* pale greenish-yellow, obtuse; dorsal sepal 4-5×2-3 mm., ovate-oblong, concave, midnerve prominent on the back with a pair of fainter lateral ones; lateral sepals 4-5×1-1.5 mm., narrowly linear, often sub-falcate, 1-nerved, margins incurved. *Petals* 3.5×1.5-2 mm., sub-oblique, ovate-oblong, obtuse, erect, greenish-yellow. *Lip* shortly clawed, fleshy, rigid, 3-lobed; claw very short, hollowed at the base; lateral lobes 3.5×5×0.5-1 mm., linear, subulate, spreading straight or upwards and backwards, slightly narrower than the midlobe, acute or obtuse; midlobe 2-3×1-1.5 mm., narrowly oblong, straight, slightly tapering to the obtuse apex. *Spur* 5-7 mm. long, straight or slightly curved, very slightly thickened towards the acute apex, shorter than the ovary, greenish-white. *Ovary* 7 mm. long, curved, faintly ribbed. *Capsule* 10×4 mm., sessile, narrowly conical, 6-ridged.

Flowering: August to October.

Occurrence in Bombay State: W. GHATS: Panchgani *Blatter & Hallberg; Sedgwick* 7596; *Saldanha* 1521; Mahableshwar, *Sedgwick* 7622. N. KANARA: Castle Rock, *Sedgwick* 2779; Mundgod, *Talbot* s.n.; Tinai Ghat, *Talbot* 2508; Yellapur, *Talbot.*

Distribution in India: Sikkim Himalaya, Khasia Hills, W. Ghats, N. Kanara, Bababudden and Pulney Hills, High Wavy Mountains. *World:* India, Burma, China.

Critical Notes: We have examined *Sedgwick* 7596, collected from the type locality of *P. xanthochlorus* Blatt. & McC., and also *Sedgwick* 7622, both specimens identified by Blatter himself as *P. xanthochlorus,* and cited under this name in the REVISION. In the absence of the type, these specimens may serve to clarify the identity of the species. There does not seem to be any definite and constant character by which such specimens may be separated from *P. densus.* In our opinion this is another case of variations induced by the conditions of the habitat. Normally *P. densus* has laxer and longer spikes; but in open rocky plateaux (as in Panchgani and Mahableshwar) plants are more stunted, somewhat stouter, and shorter; the basic floral structure of *P. xanthochlorus* is identical with that of *P. densus.*

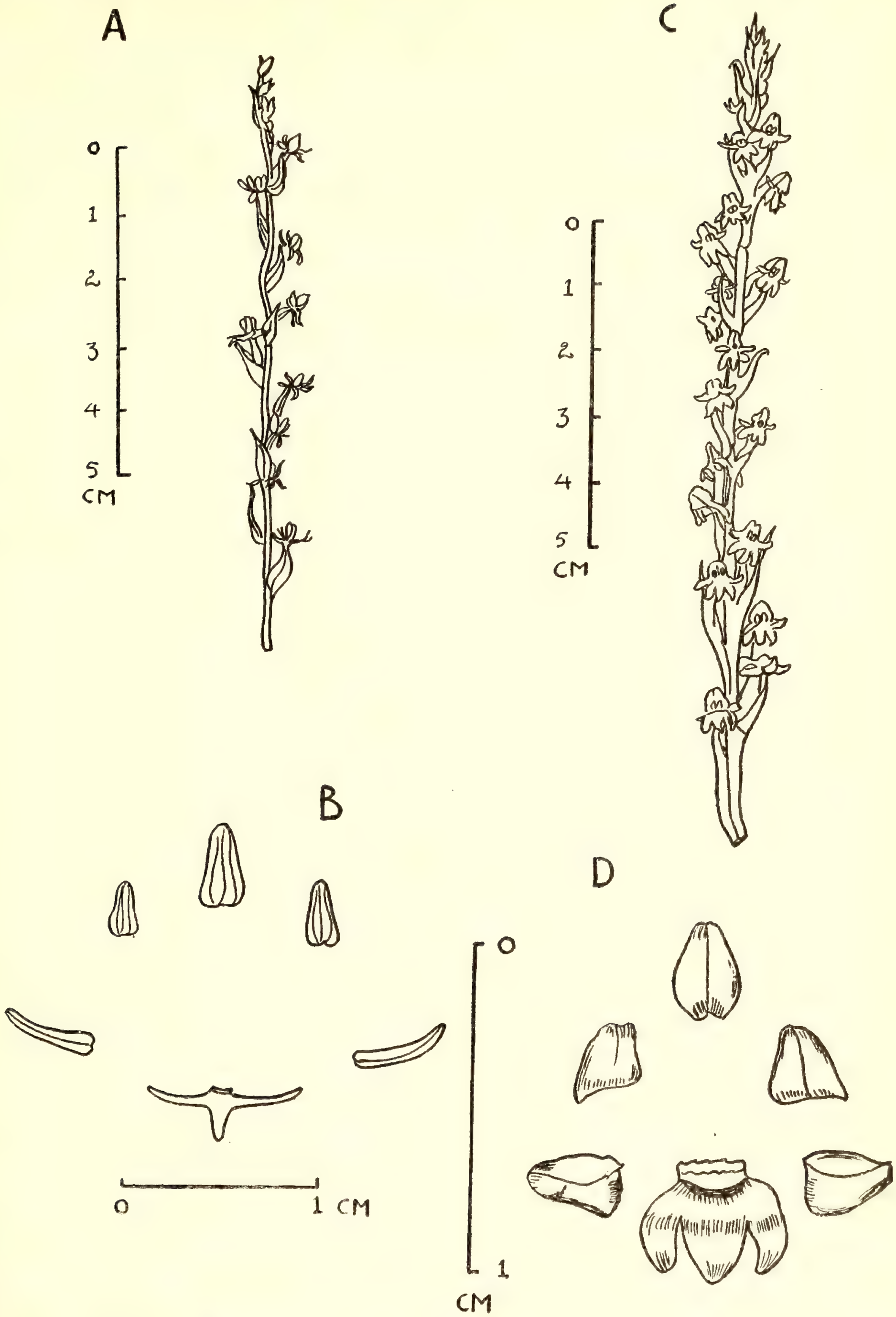
Hooker f. op. cit. p. 157 adds the remark: 'I have had difficulty in choosing a specific name, for Bentham, in adopting *stenostachya,* overlooked the older published one of *tenuis.* That of *peristyloides* may be objected to from the plant being sectionally a *Peristylus,* though Wight did not recognise it as such, and it is preoccupied by A. Richard for an Abyssinian species.' The earliest published name is, indeed, *tenuis,* but this is a *nomen nudum.* We have not been able to examine the types of *Coeloglossum densum* Lindl. and *Peristylus stenostachyus* Kränz., but from the descriptions and from Hooker's own admission they are identical; this being the case, the oldest valid name is *Coeloglossum densum* Lindl. and in consequence the correct binomial in the genus *Peristylus* for the present plant is *P. densus* Sant. & Kapad.

2. **Peristylus stocksii** (Hook. f.) Kränz. Orchid. Gen. Spec. 1: 513, 1898; Cooke 710; Gammie in Journ. Bombay Nat. Hist. Soc. 21: 172, 1911; Fischer 1475; Blatt. & McC. 735; Santapau 305. *Habenaria stocksii* Hook. f. Fl. Brit. India 6: 158, 1890; Haines, Bot. Bihar Or. 1159, 1924. (See Plate IX, C-D)

Herbs 10-50 cm. high. *Tubers* 1-2, each 1.7-3×1.2-2 cm., oblong or ellipsoidal. *Stem* slender, sheathed. *Leaves* 5-14×2-4 cm., clustered about the middle or more or less scattered on the stem, narrowed and sheathing at the base, obovate-elliptic, elliptic-lanceolate, or lanceolate to oblong, acute or subacuminate; margins wavy, yellowish, minutely papillate. *Inflorescence* lax, of many-flowered subsecund twisted spikes, 9-24 cm. long; peduncle 5-10 cm. long, slender, with a few bracts which are scaly, ovate, acute, and 1-nerved. *Flowers* small, yellowish-green, sessile, bracteate. *Bracts* 1.2×0.3 cm., more or less equalling the ovary, ovate, acuminate, glabrous, 1-nerved. *Sepals* subequal, green, glabrous, 1-nerved, sub-fleshy; dorsal sepal 3×2 mm., concave, forming a hood over the column with the petals, elliptic-oblong; lateral sepals 2.5-3×1.5-2 mm., spreading, obliquely oblong, obtuse. *Petals* 2.5×2 mm., green, sub-fleshy, sub-obliquely ovate-oblong, obtuse or sub-retuse, entire, glabrous, 1-nerved. *Lip* 3×4 mm., green, longer than the lateral sepals, 3-lobed, clawed; claw 2 mm. broad, concave; lateral lobes 1.5×1 mm., narrower than the midlobe, incurved, oblong, obtuse, entire; midlobe 1.6×1.5 mm., straight, oblong, obtuse, entire. *Spur* 6 mm. long, green, shorter than the ovary, obtuse, inflated downwards. *Column* very small, green, obtuse. Anther cells small, whitish-green, slightly divergent at the base; pollinia yellowish, clavate, obovate-oblong with a short caudicle and an exserted linear-elliptic gland; staminodes greenish-white, small, glandular, auriculate-oblong. *Ovary* 8 mm. long, green, slightly curved, ribbed.

Flowering: July to September. *Fruiting:* August to October.

Occurrence in Bombay State: DANGS: Waghai, *Santapau* 19210. W. GHATS: Igatpuri, *Kapadia* 1383; Khandala, *Santapau* 773, 805, 2491, 2579, 4575-4576, 4672, 6883-6885, 9224-9225, 9248-9249; *Irani* 1167; *Kapadia* 557-559, 561; Lonavla, *Kapadia* 541, 545; Mahableshwar, *Santapau* 13208-13209; *Kapadia* 617-619, 2077-2080; Bhimashankar, *Kapadia* 1463. N. KANARA: Yellapur, *Kapadia* 2240.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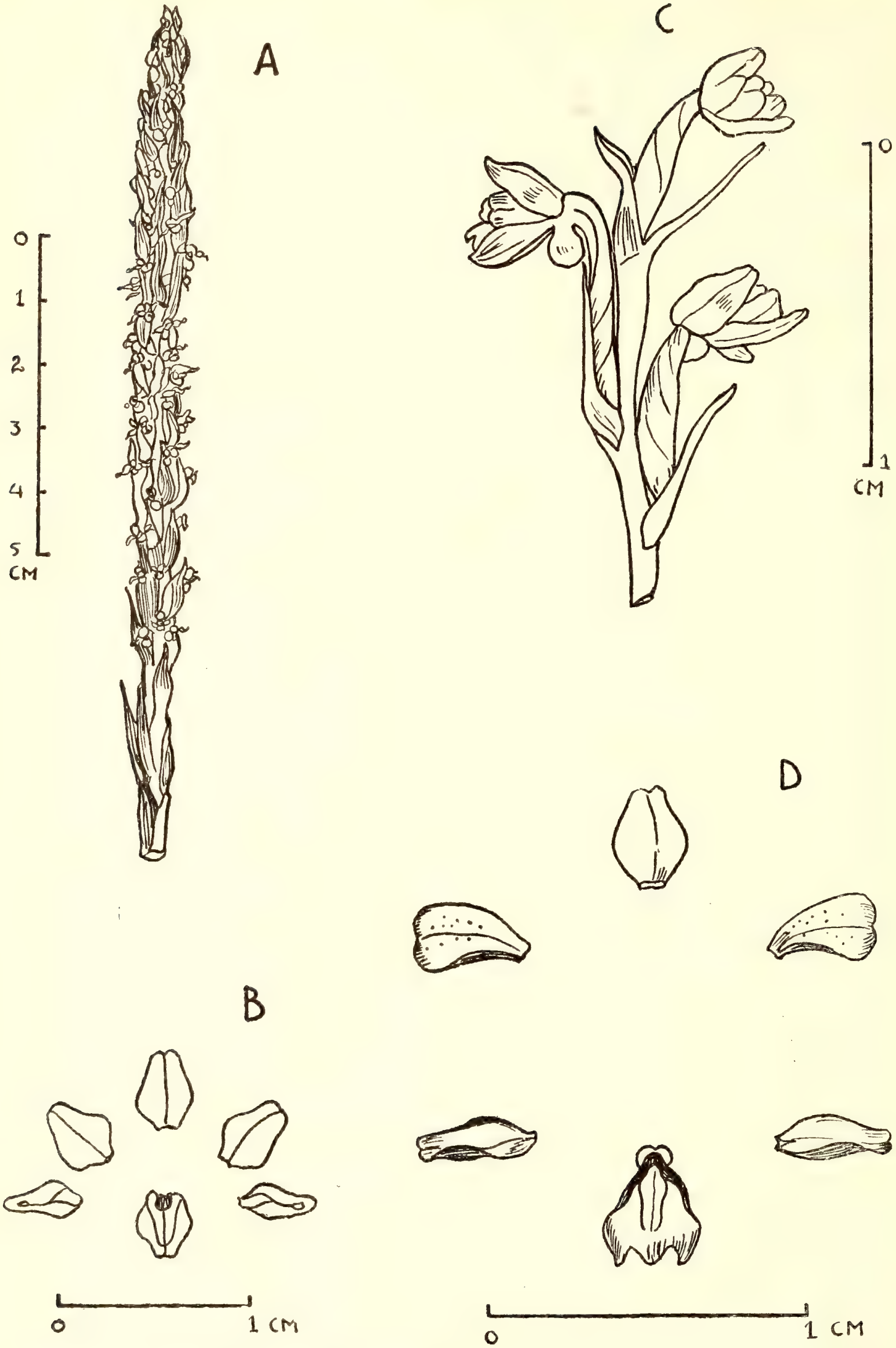
Peristylus densus Sant. & Kapad. Inflorescence (A) and dissection of calyx and corolla (B). *P. stocksii* Kränz. Inflorescence (C) and dissection of calyx and corolla (D).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Peristilus plantagineus Lindl. Inflorescence (A) and dissection of calyx and corolla (B). *P. lawii* Wt. Inflorescence apex (C) and dissection of calyx and corolla (D).

Distribution in India: Parasnath Hill, Dangs, W. Ghats, N. Kanara southwards to Mysore. *World:* Apparently endemic in India.

Critical Notes: This is a common orchid in the undergrowth of forests; together with *P. lawii* this is one of the commonest orchids in such habitats. The structure of the spur at once distinguishes this species from *lawii.*

3. **Peristylus spiralis** A. Rich. in Ann. Sc. Nat. ser. 2, 15: 69, t. 2 B, 1841; Wight, Icon. t. 1696, 1851; Cooke 711; Gammie 172; Fischer 1474; Blatt. & McC. 735. *Habenaria torta* Hook. f. Fl. Brit. India 6: 159, 1890.

We have seen no specimen of this plant in the field; there is none in Blatter Herbarium. We give, therefore, a translation of the original description of A. Richard's, loc. cit.:

'Stem slender, leafless for a foot from the base, laxly sheathed; *leaves* elliptic-lanceolate, acute, sheathing at the base, passing into bracts above, which are lanceolate, acute; *flowers* small, spicate, bracteate; *spikes* subspiral; *bracts* lanceolate, acute, longer than the flowers; *sepals* oval-oblong, obtuse; *lip* fleshy, trifid, saccate at the base; lobes subequal, linear, obtuse . . . Stem bi-tuberculate, tubers entire, ovoid-oblong, leaves narrow; flowers greenish-white . . .'

Occurrence in Bombay State: KONKAN: *Law, Stocks.* N. KANARA: Tinai Ghat, *Talbot.*

Distribution in India: Konkan, N. Kanara, Bababudden Hills, Nilgiris up to 2100 m., Travancore. *World:* India, Ceylon.

4. **Peristylus plantagineus** Lindl. Gen. Sp. Orch. 300, 1835; Wight, Icon. t. 921; Cooke 711; Gammie 173; Fischer 1475; Blatt. & McC. 735. *Habenaria wightii* Trimen, Cat. Ceyl. Pl. 91, 1885; Hook. f. Fl. Brit. India 6: 162. (See Plate X, A-B)

Herbs 17-88 cm. tall. *Tubers* 2, oblong or ellipsoidal. *Stem* robust, generally of a pinkish-brown hue, sheathed below the leaves; sheaths broad widening at the mouth, somewhat funnel-shaped, acute, the margins entire and minutely papillose, often pale yellowish-white. *Leaves* 4-8, clustered about the middle of the stem, closely sheathing at the base, sessile, brownish-green above, pale pink-brown beneath; oblong, oblong-lanceolate to broadly elliptic or elliptic-ovate, acute, 7-23×2-9 cm.; margins yellowish, entire, minutely papillose; midnerve prominent beneath with 5-7 faint lateral nerves. *Inflorescence* in spikes 9-22 cm. long, erect, strict, densely and compactly many-flowered, pale pinkish brown; peduncle 4-10 cm. long, terete, pale brown, bracteate; bracts 1.5-2×0.4 cm., ovate-lanceolate, acuminate, entire, minutely papillose, glabrous, dirty brownish-green with a yellowish margin. *Flowers* sessile, bracteate, pinkish-brown. *Bracts* unequal, the lower much longer than the ovary, the upper ones smaller, 9-14×2-3 mm., subulate, lanceolate-acuminate, pale brownish-green, somewhat strongly 1-nerved. *Sepals* subequal, dirty brown, very minutely denticulate, glabrous, strongly 1-nerved; dorsal sepal 2-4.5× 2.3 mm., concave, oblong-ovate; lateral sepals 2.5-5×1.5-25 mm., spreading, oblong, the margins incurved often overlapping. *Petals* 2.5-4×2-3 mm., white, subobliquely oblong-elliptic or rarely suborbicular, obtuse, entire, glabrous, 1-nerved, somewhat gland-dotted. *Lip* 2-3.5×2-3.5 mm., smaller than the lateral sepals, white, faintly gland-dotted, broadly ovate-oblong in outline, shortly 3-lobed; very small, entire, obtuse; base of the lip subconcave; the lip 3-nerved, midnerve running straight from the base to the apex, the 2 lateral ones slightly sinuate, meeting a little below the apex to form a loop across the midnerve. *Column* very short, pale green. *Anther* cells short, sessile on the column, divergent at the base; pollinia 2, bipartite, clavate, caudicles very small with a small, orbicular gland. *Stigmatic* lobes short, stout, convex. *Ovary* 10×2 mm., stout, curved at the apex, pale brown, ribbed.

Flowering: July to August. *Fruiting:* up to December.

Occurrence in Bombay State: DANGS: Waghai, *Santapau* 19133, 19208-19211, 19999; *Kapadia* 691-693, 1429-1435; Subir, *Santapau* 19510. KONKAN: *Nimmo* Borivli, *R. Fernandes* 2314-2315; *Herbert* 2521; Malwan, *Dalzell.* W. GHATS: Lonavla, *Kanitkar, Kapadia* 544-545; Ram Ghat, *Ritchie.* N. KANARA: Londa, *Spooner*; Yellapur, *Talbot*; *Kapadia* 2042, 2214-2223; Dandeli, *Kapadia*; Guddehalli, *Talbot*; *Bell* 7869; *Hallberg & McCann* 34896; *Kapadia* 2131; Karwar, *Hallberg & McCann* 34375, 35014.

Distribution in India: Madhya Pradesh, Dangs, Konkan, W. Ghats, N. Kanara, Rampa Hills in Andhra, Annamalais, Malabar, Travancore. *World:* India, Ceylon.

Critical Notes: This species is typical of dense forests, but is usually found only in clearings in the forest, along forest paths, etc. Hooker f. has given *P. elatus* Dalz. as a synonym of this species; Alston has kept it as a distinct and valid species but in the genus *Habenaria* as *H. elata* (Dalz.) Alston in Trim. Handb. Fl. Ceyl. 6: 280, 1931. Dalzell & Gibson in their BOMBAY FLORA mention that the lateral sepals of *P. elatus* Dalz. are mucronate on the back; this is certainly not the case with *P. plantagineus* Lindl.

5. **Peristylus goodyeroides** Lindl. Gen. Sp. Orch. 299, 1835; Dalz. & Gibs. Bombay Fl. 300, 1861; J. J. Smith 32, t. 14; Fischer 1475; Blatt. & McC. 735. *Habenaria goodyeroides* D. Don, Prodr. Fl. Nep. 25, 1825; Graham, Cat. 201, 1839; Hook. f. 161; King & Pantling 326, t. 430; Duthie 192; Prain, Bengal Pl. 1039; Holttum 86. *H. affinis* D. Don, op. cit. 25, 1825. *Peristylus goodyeroides* var. *affinis* Lindl. op. cit. 300, 1835; Cooke 712; Gammie 173. *Habenaria goodyeroides* var. *affinis* King & Pantl. op. cit. 327, t. 430 (bis), 1893.

Herbs 37 cm. tall. *Leaves* more or less clustered about the lower third of the stem, sessile, hardly narrowed to the sheathing base, broadly ovate-elliptic or elliptic, about 7-nerved, acute, 7-11×4-4.5 cm.; margins entire, yellowish, minutely papillose. Peduncle 10 cm. long, terete, grooved, with a single bract, which is 3×0.6 cm., oblong-lanceolate, acute, entire and minutely papillose. *Spike* erect, very lax, 14.5 cm. long. *Flowers* about 10 mm. long, sessile, bracteate. *Bracts* lanceolate, acuminate, acicular, equal to or longer than the flowers, entire, minutely papillose, 1-3-nerved, each 12-20×3-4 mm. *Sepals* unequal; dorsal ovate-oblong, obtuse, entire, 3.5×1.5-1.75 mm.; lateral ones 4×1.5 mm., obliquely obovate-oblong or oblong, concave, 1-nerved, mucronate a little below the apex, which is somewhat incurved and acute. *Petals* trapezoidal-obovate, rounded, entire, 3×1.5 mm. *Lip* longer than the petals, 3-fid to below the middle, 3-4 mm. long; lateral lobes narrowly linear-oblong, obtuse, entire; midlobe very slightly shorter than the side-lobes, obovate-oblong, tapering to a blunt, subtruncate entire apex. *Spur* long, saccate, ovate-globular, 1.5 mm. long. *Ovary* twisted, shallowly ribbed, sessile, 6-7 mm. long.

Flowering: August.

Occurrence in Bombay State: KONKAN: *Nimmo, Dalzell.* N. KANARA: Castle Rock, *Sedgwick ex Blatt. & McC.* Devimane Ghat, *Sedgwick & Bell ex Blatt. & McC.*

Distribution in India: Dehra Dun, Sikkim, Khasia and Naga Hills, Konkan, N. Kanara, W. Ghats of Bombay, and southwards. *World:* India, Nepal, Ceylon, China, southwards to Malaysia.

Critical Notes: We have studied a specimen from Travancore collected by Calder & Ramaswamy, very kindly loaned to us by the Curator, National Herbarium, Calcutta. Our plant differs somewhat from the typical forms described and illustrated by King & Pantling, Duthie, and others, in that the spikes are very lax, and the floral bracts are sharply acuminate and about twice as long as the entire flower.

Hooker f. op. cit. 166, considers *H. affinis* D. Don. a small state of *H. goodyeroides* D. Don. King and Pantling reduce the former to a variety of the latter. Cooke points out that it is the var. *affinis* that has been recorded from Bombay; on the other hand Blatter and McCann do not distinguish the variety from the typical plant. After carefully examining the descriptions and illustrations of these plants, we have come to the conclusion that the so-called variety does not deserve even varietal rank, and for this reason we have merged it with the typical species.

6. **Peristylus lawii** Wight, Icon. 5: 12, t. 1695, 1851; Dalz. & Gibs. 270; Cooke 710; Gammie 174; Blatt. & McC. 735. *Habenaria lawii* Hook. f. Fl. Brit. India 6: 162, 1890; Prain, Bengal Pl. 1032; Duthie 192, t. 143 & Fl. Upp. Gang. Pl. 3: 227, 1920; Haines, Bot. Bihar Or. 1160. (See Plate X, C-D)

Herbs 15-45 cm. high. *Tubers* 1-2, oblong-obovate, somewhat flattened. *Stem* terete, brownish-white, stout, sheathed; sheaths 2-3, each 1.5-3 cm. in length, broud-mouthed, oblong. *Leaves* 3-5, clustered about the middle of the stem, not reduced to bracts above, sheathing at the base, lanceolate or oblong-lanceolate, acute, entire, minutely papillose, glabrous, grass-green above, pale dull green beneath, 3-13×2-4 cm. *Inflorescence* in somewhat lax spikes, 8-18 cm. long; peduncle ebracteate, terete, green, 4-7 cm. long. *Flowers* sessile, white tinged with greenish-yellow, bracteate. Bracts lanceolate, acuminate entire, shorter or longer than the flowers, 1-nerved, 5×2 mm. *Sepals* subequal, white; dorsal sepal ovate-oblong, obtuse or subretuse, entire, 1-nerved, concave, 3×2 mm.; lateral sepals oblong, obtuse, subconcave, conduplicate, entire, glabrous, 1-nerved, 3.5×1.5 mm. *Petals* obovate in outline, retuse. *Lip* 3-lobed about the middle, clawed, 3.5×2.5 mm.; claw slightly elongate, concave; lobes subequal, lateral ones about 1 mm. long, rounded, curved on the outer margins, subacute, slightly longer than the straight obtuse midlobe. *Spur* small, scrotiform, 1 mm. in diameter with a circular depression all round. *Column* very short, greenish-white. *Ovary* pale green, ribbed, about 5 mm. long. *Capsule* fusiform, turgid, ribbed, 1-1.5 cm. long; beak 3-5 mm. long.

Flowering: July. *Fruiting:* September.

Occurrence in Bombay State: DANGS: Waghai, *Kapadia* 1420. KONKAN: NW. of Bhiwandi, *Santapau* 233/3; Hills SE. of Tansa Lake, *Santapau* 15876; Badlapur, *Kapadia* 1291; Neral, *Bhiva.* N. KANARA: Belgaum, *Law*; Dharwar, *Law ex Stocks.*

Distribution in India: Dehra Dun, Garhwal, Bengal, Bihar, Madhya Pradesh, Dangs, Konkan, W. Ghats, N. Kanara, Mysore. *World:* Apparently endemic in India.

Critical Notes: This species has been found by us in fairly dense undergrowth on sloping ground, on hilly parts of Bombay State. This and *P. stocksii* are the only species that can be said to be common in Bombay; the spur of the present species is typical.

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Constancy to horticultural varieties shown by butterflies, and its possible evolutionary significance

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Since Aristotle it has been known that bees of a particular colony showed a constancy to one species of flower until the local population of this was exhausted of its nectar. Recent discussions (e.g. Ribbands 1953, Butler 1954) are agreed that a few workers of a hive scout for adequate sources, and inform their comrades, who exploit these sources to exhaustion before turning their attention to newly discovered supplies. Mather (1947) has shown that in the genus *Antirrhinum* at least, this constancy is species specific.

While working in a small experimental garden consisting of three plants each of two colour varieties of the primarily South American species *Lantana camara* L. Dronamraju (1958) observed that the different varieties were preferentially visited by different species of butterflies. The two varieties of *Lantana* are those which are overwhelmingly preponderant among the feral population around Calcutta. In one called *pink* the newly opened florets are white except for the yellow honey guides, but the unopened buds and the ageing florets at the periphery of the inflorescence are pink. In the other variety called *orange* the buds and ageing florets are orange and the young florets yellow. Both forms set seed, and the specimens in our garden were collected as seedlings. It has so far proved impossible to cross these two varieties, and Dr. E. K. Janaki Ammal tells us that it is probable that they are of different ploidies. K.R.D. began watching the garden again next spring and has now spent 46.75 hours all told attempting to note all visits of all species of insects. Among these were 9 species of Papilionoidea. We have also casually observed other species of butterflies at other times and seasons, in other places, on the same varieties, and on other varieties, (and perhaps species), of *Lantana*.

Table 1 shows the data collected for the six most frequent visitors (Dronamraju 1960). The unit counted is the insertion of the proboscis into a floret, from now on to be called a *feed*. The movements of

TABLE 1

Species	Family	Date of		Number of days observed	Number of feeds	
		1st observation	last observation		on orange	on pink
Precis almana ..	Nymphalidae ..	29-5-58	21-4-59	16	218	13
Danais chrysippus ..	Danaidae ..	19-3-59	22-5-59	18	142	152
Papilio polytes ..	Papilionidae ..	19-3-59	4-4-59	4	15	31
Papilio demoleus ..	Papilionidae ..	19-3-59	19-5-59	13	42	98
Catopsilia pyranthe .	Pieridae ..	29-5-58	22-5-59	27	40	603
Baoris mathias ..	Hesperiidae ..	19-3-59	19-5-59	12	1	108

normally feeding butterflies are sufficiently slow for these feeds to be counted. Only in the counts of *Baoris mathias* is it believed that the movements were so rapid that any large number of feeds were unnoted. Such an underestimate would increase the significance of the preference for pink shown by this butterfly. Smaller data on other species showed statistically significant preferences, but because they were collected during too short a period of time they may only record individual preferences, or temporary constancies such as are known for *Apis mellifera*, and were observed during this same series of observations for *A. florea*.

On the totals it is clear that 5 species have a distinct preference for one colour variety rather than the other. The length of the periods during which the observations were made, and in some species the use of individuals which were sexually dimorphic, or marked by injury, or paint, makes it clear that several individuals of each species were observed. We cannot assume that all these individuals either had indistinguishable experiences, or alternatively were influenced by some previously unsuspected social reaction to a variety first visited by one individual. Therefore we think that these data make it most unlikely that an individual butterfly of these species emerges from its pupa indifferent to which colour of *Lantana* it feeds upon, and becomes conditioned or imprinted by its own individual experience.

Danais chrysippus judged by the totals given in Table 1 has no preference. However the data are highly heterogeneous. Statistical estimation cannot be made because so many observation periods included only one or two feeds.

Therefore we give (Table 2) the number of feeds during the two hours when most visits of this species were recorded. Both were between 8 and 9 a.m.

TABLE 2

Date	Orange	Pink
22-3-59	0	46
7-5-59	50	7

Formally such counts resemble those that are obtained by watching a colony of bees visiting a mixed crop, but before we postulate that *Danais chrysippus* has a social organisation, we will discuss our observations on the first feeding behaviour of twelve individuals of *Papilio demoleus* that emerged from their pupae in the laboratory.

This species is the only one of those observed of which we have obtained larvae to experiment upon. Professor B. Rensch in a letter to Professor J. B. S. Haldane commenting on Dronamraju's paper of 1958 had suggested that these preferences might be due to the butterflies becoming imprinted to flowers of the colour of their first feed. Therefore, because wild *P. demoleus* showed a significant but not extreme preference for pink, we exposed ten of these twelve animals to orange flowers alone, including holding them on to the inflorescences if they did not alight voluntarily. After at least half an hour if they did not feed, or after at least 40 feeds if they accepted orange, pink was presented. The other two butterflies were offered a choice. One (♂ 4) always flew away when held on inflorescences of either colour during the hour's observation period, though he inserted his proboscis once into an inflorescence. This was a pink inflorescence on which he had been placed and on which he subsequently remained unfeeding for 17 minutes, only leaving when disturbed. Next day he was not offered a choice and refused orange for half an hour but then accepted pink. The record of the other animal offered a choice (♂ 7) is graphed in Fig. 2.

Any number from 4 to 40 inflorescences of one colour were offered on cut stems, and care was taken to match the specimens of the two colours in number and condition to human eyes. Also note was taken as to whether the flowers were freshly gathered, previously used that day for butterfly feeding experiments, or the present mature florets had opened in the laboratory sheltered from any insect visits. We have only tenuous evidence that our flowers were ever exhausted enough for their interest to decrease for a butterfly.

At first the experiments were performed in a large room with windows in three walls. One butterfly fed on orange and was immediately eaten by a gecko; another refused orange for 2 hours and 40 minutes and then walked through a draining hole—and instead of flying away fell from four storeys and was recovered (she was marked) with a fractured costa! The third produced clear results and was observed on 6 consecutive days. All other animals were observed in a small wire and wood cage 2.1×1.5×2 cu. m. in volume. Two people were necessary, one to observe (usually KRD) and one to write (usually HS), mainly but not exclusively from dictation, because the butterflies, being starved, fed more rapidly than free animals. No sugar water had been given before the experiments to be described.

Table 3 sums up our conclusions, and Figs. 1 and 2 graph two experiments to demonstrate the behaviour which we categorise as 'feeds on orange; prefers pink'. In both the figures the horizontal axis represents time, and there are four distinct vertical axes. The black

TABLE 3

Papilio demoleus
First feeds in captivity

	Prefers Orange	Prefers Pink	?
Feeds on Orange ..	3	3	1
Does NOT feed on Orange ..	..	4	1

histograms represent separately the number of feeds on orange and pink, and the white histograms the number of *landings*, i.e. the number of times the butterfly alighted and stood on an inflorescence. We have never seen a *Papilio demoleus* feed without landing, but these butterflies often land without feeding. The horizontal lines represent the period of time when flowers of that colour were present. Pink was

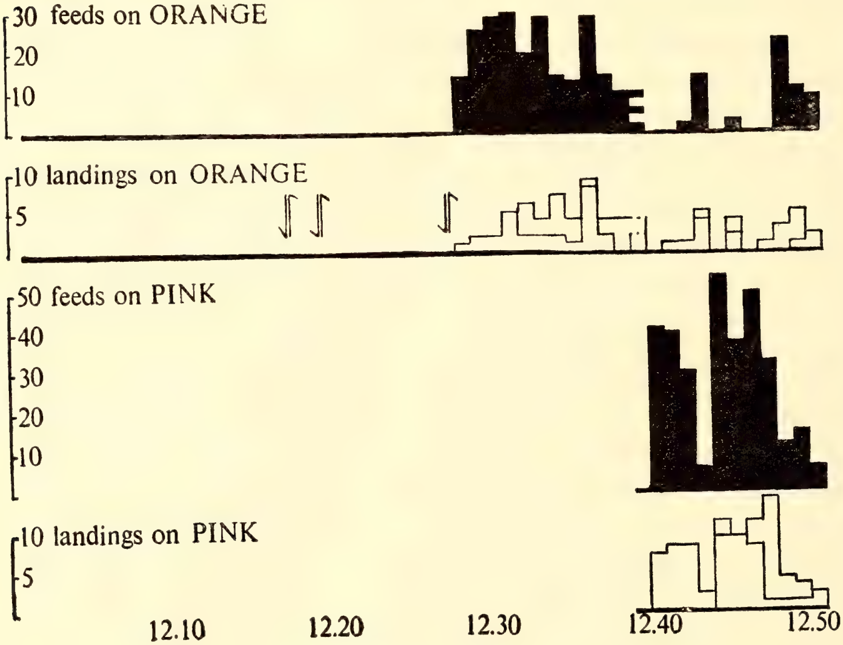

Fig. 1.

Papilio demoleus ♀3 feeding on *Lantana camara* 24-8-1959.

only presented to ♀ 3 (Fig. 1) at 12.39 hours, after the animal had fed upon orange; pink was removed from ♂ 7 (Fig. 2) at 16.14 hours, after it had been fed upon, and returned at 16.24; orange was present throughout both experiments. In the experiment with ♀ 3 two vases of both colours were presented and the histograms of landings are divided into two parts to indicate when she flew from one vase to another. When all four vases were presented they were arranged alternately in a row so that a vase of another colour had to be flown over with every change. In Fig. 1 the arrows indicate when the animal

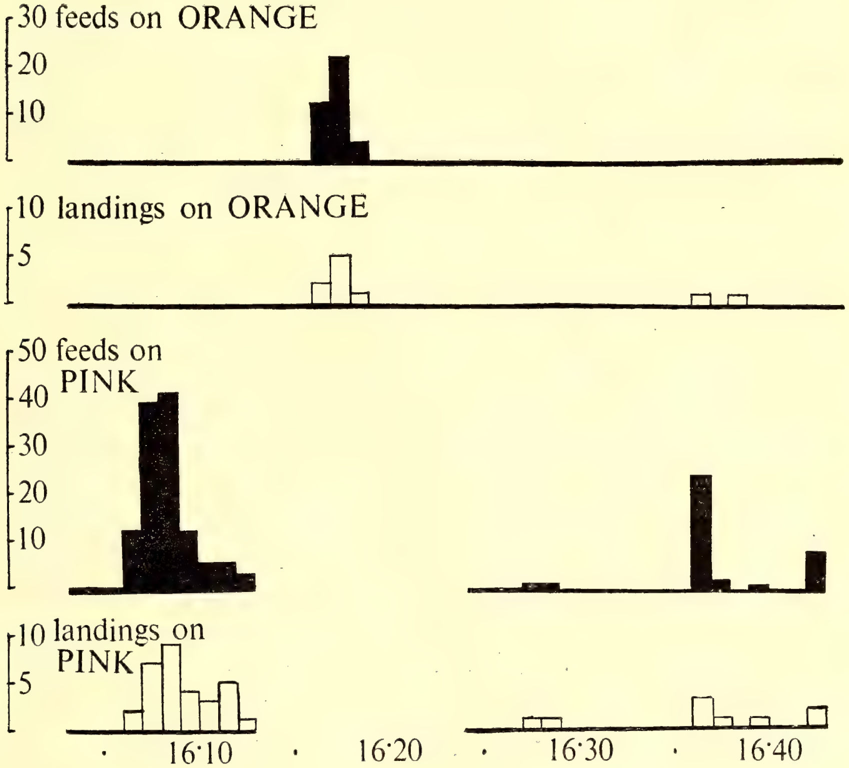

Fig. 2.

Papilio demoleus ♂7 feeding on *Lantana camara* 28-8-1959.

was forcibly held on to the flowers. She always flew away when released. The dotted histograms represent feeds and landings uncounted because the observers were occupied in introducing the vases of pink flowers. It will be seen that both these animals did feed on orange, but were reluctant to do so especially in the presence of pink. The second supply of pink offered to ♂ 7 consisted of only four inflorescences which had been ardently fed upon (194 feeds) five hours before. Nevertheless they held his attention from the four orange to which he only had had access, and on which he had only fed 36 times.

The series of experiments summarised in table 3 support the theory that most individuals of *P. demoleus* emerge from their pupa with a preference for feeding on pink *Lantana* rather than orange and that this is not altered by receiving their first food from orange flowers. The three animals who continued to feed on orange after pink was made available were a mother, one son, and one daughter. The father and another son and daughter were tested and preferred pink. Thus a minority of *P. demoleus* prefer orange in the sense of behaving thus in our experimental conditions. If this difference is genetically determined it is a behavioural polymorphism, and a similar polymorphism present in *Danais chrysippus* would explain the observations on wild animals in Table 2. A similar heterogeneity can be discerned in the data on wild *P. demoleus*, but the individual observations are too few for this to be demonstrated as significant.

We have been able to find only one previous recording of a similar phenomenon. Eltringham (1933) observed specimens of *Vanessa urticae* (an orange Nymphalid not unlike *Precis almana*) visiting a bed of asters (Compositae) of which white, purple, and pink flowers were in the approximate proportions 7:9:12. However, out of 427 visits 47 were to white, 245 were to purple, and only 135 were to pink (from discussion by Ford 1945 who gives more details). These observations raised the question of whether the animals distinguished by colour vision, and led to the establishment of the fact of colour vision in butterflies (discussed by Ford *loc. cit.*). However its relevance to these flower preferences was not established, and the same question must be asked about our own observations. Because a pink-preferring butterfly does in our experiments feed on pink, white, and heliotrope flowers of other nectar-bearing species, while ignoring nectar-bearing orange and yellow flowers, we believe that these animals are reacting to colour and not to some other stimuli correlated with it in these *Lantana* stocks. However we do not want to stress this belief yet, as the flowers presented were very heterogeneous in structure, and not every species with pink flowers was visited.

Whatever the nature of the stimulus, such preferences will exert a selection pressure on the plant population comparable to that exerted by sexual selection in animals. A learnt preference will exert much less selection; a bee changes its behaviour to accommodate, or to adapt to, every change in the source of nectar. An instinctive preference will either sterilize a new mutant because few or no pollinators visit it; or preserve the phenotype because it is pollinated by animals who rarely mix its pollen with that of the unchanged parental population, i.e. whose behaviour favours homogamy. So if a new mutant is recessive the butterflies' behaviour will maintain homozygosity once a few homozygotes have segregated in a population; if the mutant is a dominant so that the first unusual phenotype is a heterozygote this will be self-pollinated by the pollinators and so produce homozygotes which will be maintained by the same behaviour. The two phenotypes will be more or less isolated sexually, and thus have the possibility to become further differentiated. In short is this an insect capacity which could make possible in a plant population the initiation of sympatric speciation by a single gene mutation? Mayr (1947) considered and rejected the possibility of sexual isolation arising by a mutation producing a change in a preference. The butterflies we have described have established preferences and it is these which could exercise selection pressure on any mutants that altered relevant stimuli.

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Systematics and Ecology of Indian Plants: I—On the Rainy Season Weeds of Gorakhpur

BY

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(*With a sketch map*)

INTRODUCTION

The author has tried in this paper to contribute towards the flora of Gorakhpur on the lines suggested in the address by Santapau (1956). The vegetation of many places has been commonly described in different seasons, but such a study has rarely been undertaken during the rainy season on account of inherent difficulties, and so the monsoon and cold months of the year have often been left out completely.

In this paper an attempt has been made to present the rainy season weeds of Gorakhpur. Among other difficulties during this season, as mentioned by Santapau (1956), the pressing and the preservation of plants is the main problem, because most of the plants collected during moist weather become unsuitable for preservation as herbarium materials. Excursions were made whenever possible, and features of interest connected with the phenology and ecology of these plants have been noted. Some of the plants, though quite obvious by their presence flower quite late in this season. Then there are plants which are present throughout the year, but flower profusely during this season. Some plants which do not strictly belong to this season have also been included here because of their particular character. Their density of population in certain localities has been recorded. The flowering time of plant species has been indicated as precisely as possible. The time of seed germination of those plants which could be identified at the seedling stage has also been recorded. The author was advised to include the medicinal properties of the plants recorded here. In this connection no help has been taken from published literature, but only information gathered from local inhabitants has been made use of.

Hewetson (1951 & 1952) and Santapau (1956) have stressed the necessity of a systematic plan in the study of the flora of a place, by extending the scope of such studies beyond the usual practice. The mere enumeration of plants is not of much avail. The record of distribution, information about soils on which the plants flourish, altitude, phenology, fruit setting, relative abundance and scarcity, and the associations they form are very important, as also the various stages, namely germination, vegetative growth, and finally the formation of seeds.

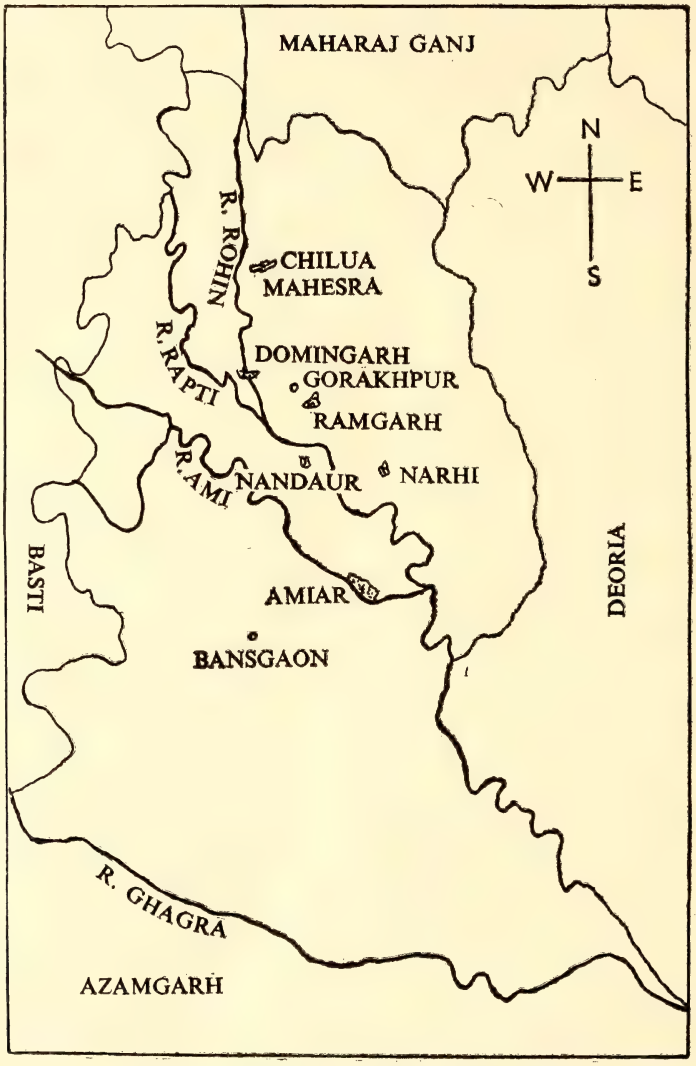
It is only in recent years that attention has been drawn to such a field of study by a number of botanists. But apparently not many have dealt with this subject matter from the ecological point of view, at least in Uttar Pradesh. The earliest records in this field are those of Dudgeon (1920) and Kanji Lal (1933), which do not deal particularly with the vegetation of Gorakhpur. There are records of a systematic study by Raizada (1931, 1935, 1936, 1939) and Srivastava (1938). As to the ecological and morphological aspects, Misra (1944, 1946) has included them in a number of papers on the vegetation of Banaras. Recently Srivastava (1955), Jain (1956), Gupta (1956), and Bhargava & Gupta (1958) have contributed to the vegetation of different regions of Uttar Pradesh. The last mentioned workers emphasize mainly the phenology of plants in Naini Tal.

A survey of the above mentioned literature shows that, except for Misra, no work on the vegetation of the eastern parts of Uttar Pradesh has so far been carried out. Very recently the author (Sen, 1959) has made an ecological survey of the aquatic and swampy vegetation of Gorakhpur. The main aim of the author is to give an account of different aspects of vegetation in different seasons of the year from the ecological point of view. The results will be communicated in a series of papers.

SITUATION AND PHYSIO-GEOGRAPHY

The district of Gorakhpur lies between the Nepal Terai in the north and the Ghagra River in the south, which separates it from Azamgarh district. The western boundary is the Basti district ; and on the east is Deoria which was formerly part of Gorakhpur. The geographical limits are 26°5′ and 27°29′ N. and 83°4′ and 84°26′ E. Owing to changes in the courses of the rivers Ghagra and Rapti there has been a continual change in the area.

The district has almost a uniform height of 270 feet above sea-level. The plain slopes gently first to the south and then to the east, indicating the general drainage of the country from NW. to NE. A remarkable feature of its landscape is the total absence of marked topographical features. The region comprises several low-lying areas irregular in shape and size, where owing to defective drainage, water accumulates during the rainy season. There are large bodies of stagnant water locally known as *tals*. These low-lying areas are depressions in the flood plains, which the rivers by flooding are trying to bring to the general level. Many such areas are seen in the north of Gorakhpur city (see Sen, 1959). The tract is completely devoid of any hill or conspicuously marked high land.


MAHARAJ GANJ
N
W
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CHILUA
MAHESRA
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GORAKHPUR
RAMGARH
R. AMI
NANDAUR
NARHI
BASTI
DEORIA
AMIAR
BANSGAON
R. GHAGRA
AZAMGARH

Map of Gorakhpur showing some localities

Floods have been a regular menace in the district of Gorakhpur. The river Rapti is one of the largest Himalayan tributaries of the river Ghagra. It flows in a south-easterly direction and drains a large basin. The river Ghagra rises in Tibetan mountains ; like most Himalayan rivers it first flows south and then takes an easterly turn. Gorakhpur, being very close to the Nepal Himalayas and lying in the windward side of the monsoon, gets more rain than other more southern districts ; the latter through these two important rivers, the Ghagra and the Rapti, very often suffer serious floods.

The district is part of the Gangetic plain. Its formation, therefore, is of the same geological structure and history as the plains of Uttar Pradesh. This plain has been continually filled with alluvial deposits since the first uplift of the Himalayas. Attempts have been made to ascertain the depth of the alluvial deposit, but no definite results have been achieved.

CLIMATE

In the rainy season the average temperature of Gorakhpur is 29°C., which is a little lower than the average temperature of dry summer. The difference may be due to the humidity.

TABLE

METEOROLOGICAL DATA OF GORAKHPUR—1959

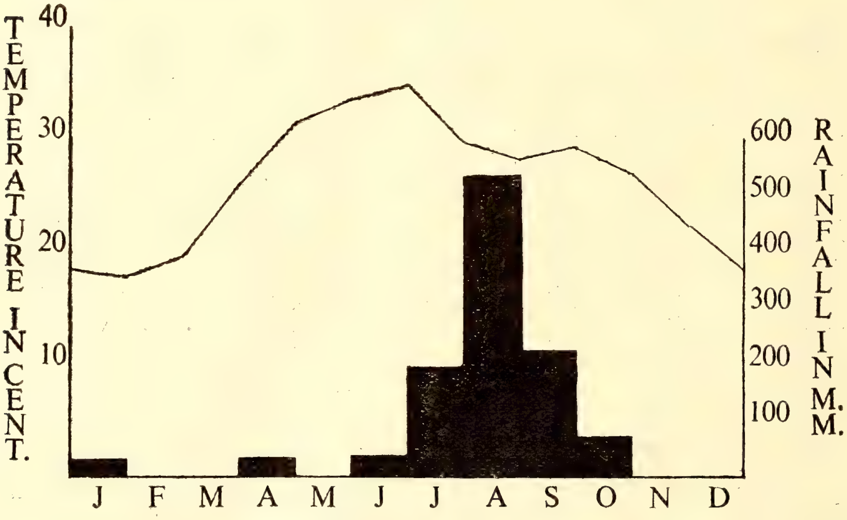
Months	Temperature in °C.		Relative Humidity %		Rainfall in mm.	Average Wind Speed Kilom. p.h.	Mean Temp. in °C.
	Mean Max.	Mean Min.	At 08.30 I.S.T.	At 17.30 I.S.T.			
Jan.	24.6	11.3	81	56	31.0	2.4	17.91
Feb.	26.5	13.0	65	42	00.0	4.4	19.75
Mar.	34.4	17.9	46	23	2.5	5.7	26.15
Apr.	39.2	23.8	44	26	34.3	6.0	31.50
May	41.3	25.4	50	23	00.0	7.7	33.35
June	42.1	27.5	62	43	39.9	7.7	34.80
July	33.8	25.7	81	75	*c.*197.9	7.0	29.75
Aug.	31.7	24.7	88	86	*c.*535.7	4.1	28.20
Sep.	33.2	25.1	81	77	*c.*221.8	4.7	29.15
Oct.	31.8	22.3	75	70	70.6	2.4	27.05
Nov.	29.7	15.1	60	55	00.0	1.1	22.40
Dec.	24.1	12.6	80	71	00.3	2.0	18.35

In May and June there is low pressure in the Punjab near Multan. The prevailing winds, therefore, become on-shore blowing from the sea to the land. In the beginning, while summer temperatures are rising, these sea winds move only a short distance from the Bay of Bengal. As the temperature rises these winds penetrate into the interior and are called the summer monsoon. The monsoon arrives in the month of June. The mean daily velocity varies between 7.0 and 7.7 kilometres per hour in these months.

Throughout the rainy season the monsoon winds are easterly. Their velocity decreases as the rainy months pass on ; and then the direction of the wind changes, becoming ultimately from the east in the morning and the west in the afternoon.

The monthly relative humidity, as shown in the Table, indicates that March and April are the driest months in Gorakhpur. With the advent of the rainy season, the relative humidity increases considerably. It again goes down in October.

As a whole, Gorakhpur receives a heavier rainfall than any other part of the province excepting the hilly tracts, the average being no less than 94.5 mm. The Bay of Bengal branch of the south-west monsoon is mainly responsible for the heavy rains ; the district being on the windward side receives much rainfall. Usually the strength of the monsoon currents and the corresponding rainfall increase from June to July and remain more or less steady till about the end of August. The rain is unevenly distributed throughout the year. Nearly 78% of the total rainfall of the year falls in the four months, July to October. Heavy downpours lead to considerable runoff, which results in soil erosion. The region north of Gorakhpur city, on account of defective drainage, the presence of forests, and the heavy rainfall in the northern tract, usually becomes marshy and moist.



Annual Temperature and Rainfall at Gorakhpur—1958

BIOTIC FACTORS

Among the biotic factors which influence the vegetation is the grazing by cattle. In places monkeys destroy the tender vegetation. Man also destroys much of the rainy season weeds, which grow quickly and, if not cleared up, give a wild look to the whole area.

General Aspect of Vegetation

With the arrival of the rainy season (June to July) green herbs appear in every nook and corner. A vigorous and luxuriant growth of weeds starts with the first showers. The *ephemeral vegetation* consists mainly of herbaceous annuals, the existence of which mainly depends upon rain. After a week or two of rain, the ground is covered by plants which belong strictly to the rainy season. Among them *Cleome viscosa*, *Gynandropsis gynandra*, *Ionidium suffruticosum*, *Dentella repens*, *Indigofera* sp., *Cassia* sp., *Trienthema portulacastrum*, *Spermacoce hispida*, *Heliotropium* sp., *Ipomoea pes-tigridis*, *Bonnaya* sp., *Murdannia nudiflorum*, *Peperomia pellucida*, *Phyllanthus* sp., *Cyanotis* sp., *Commelina nudiflora*, *Sesamum indicum*, *Fleurya interrupta*, *Pouzolzia indica*, *Evolvolus alsinoides*, etc. Others germinate and grow vegetatively till late in the rainy season and then come into flower, like *Urena lobata*, *Sida* sp., *Triumfetta* sp., *Oldenlandia crystallina*, *Pergularia pallida*, *Ipomoea sindica*, *Physalis minima*, *Vitis trifolia*, *Ruellia* sp., *Acalypha indica*, etc. There is a third category of weeds which germinate late in rainy season ; they start flowering quite late and go on till about the middle of the winter season. Such weeds include *Oxalis corniculata*, *Tephrosia purpurea*, *Peristrophe bicalyculata*, *Andrographis paniculata*, *Ageratum conyzoides*, *Croton sparsiflorus*, *Scoparia dulcis*, *Adhatoda vasica*, *Ocimum americanum*, *Alternanthera sessilis*, *Nicotiana plumbaginifolia*, etc. There is a fourth category of plants, which are more abundant in other seasons of the year but may sprout and even flower at odd times during the rainy season ; some plants in this category flower throughout the year but do so more profusely in the rainy season. Such plants are *Malvastrum coromandelianum*, *Tridax procumbens*, *Evolvulus nummularis*, *Solanum xanthocarpum*, *Achyranthes aspera*, *Tribulus terrestris*, and others.

Some of the plants complete their life-cycle in a few weeks. Plants first start drying out from the exposed habitats. Many plants in shaded places last for quite a long time. Some of the plants disappear with the departure of rain and the advent of the cold winter. Life without water and moisture is difficult for them. This will be clear from the periodicity chart at the end of this paper. The commonest and most successful weeds belong to Amarantaceae, Tiliaceae, Malvaceae, Compositae, Capparidaceae, Leguminosae, Convolvulaceae, Acanthaceae, Gramineae, and Commelinaceae.

Conclusion and Summary

In the present paper an attempt has been made to study the vegetation of Gorakhpur in the rainy season from the ecological point of view. Some advancement has been made in India during recent years on floristic and vegetational studies but most parts are still in need of very thorough exploration. It would not be wise to separate systematic botany from ecological studies, and hence different observations have been included here ; the phenology of each plant, its short life-cycle, relative abundance, and distribution, as has been emphasized by Santapau (1956).

Keeping all this in mind, this study has been made, which in no way claims to be complete. Even a small area may be too large for intensive exploration. The grasses have not been included in this paper, otherwise it would become very unwieldy. The author intends to make a separate communication on the subject. The present paper mainly deals with those weeds which come up soon after the first showers of the season ; trees and shrubs are excluded, although many also come into flower at this time of the year. 147 species representing 107 genera from 39 families have been recorded. Plants belonging to Malvaceae, Tiliaceae, Leguminoseae, Rubiaceae, Compositae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Labitae, Amaranthaceae, Euphorbiaceae, and Commelinaceae families are more common. Wherever possible some medicinal uses of the plants have also been given.

Ecologically, the vegetation can be divided into : (1) those plants which are strictly of the rainy season, i.e. they come up with the rains and complete their life-cycle with the departure of the rains, like *Gynandropsis gynandra* and *Ionidium suffruticosum*, etc. ; (2) those which grow with the rains but complete their life-cycle after the rains are over, like *Physalis minima*, *Urena lobata*, etc. ; and (3) those which germinate late in the season and flower only in winter or so, like *Peristrophe bicalyculata*, *Leonotis nepetaefolia*, etc. Taking this division strictly into account, a few plants can be excluded from this list, but as there is no strict demarcation of changing seasons, so also the plants pass from one flowering season to the other, depending mainly on the environmental factors, which definitely affect them.

ACKNOWLEDGEMENTS

Thanks are due to Prof. U. N. Chatterji of Gorakhpur University for constant encouragement and constructive criticism in the preparation of this paper ; to Prof. M. O. Varkey, Principal, St. Andrew's College, Gorakhpur, who very kindly passed on his field notes to the author, and for the facilities provided ; to my colleague Prof. G. C. Srivastava for many suggestions and identifications. The author is thankful to Shri M. B. Raizada, Forest Botanist, F. R. I., Dehradun, for kindly helping him in the identification of a few plants, and to the Director, Meteorological Centre, for supplying the meteorological data. He is indebted to his colleagues and many students for help given in this study. Finally, he is extremely grateful to Rev. Fr. Santapau for kindly

going through the manuscript of the paper, which is the outcome of his most inspiring address.

LIST OF SPECIES

A list of weeds collected throughout the rainy season, with a brief description, the locality where they were collected, their local names (wherever possible), the time of seed germination, flowering, and fruiting. Medicinal uses of some of the plants have also been listed. The names are arranged according to Bentham and Hooker's system, as in Duthie's FLORA. Local names are given after the scientific names or synonyms.

CAPPARIDACEAE

1. **Cleome viscosa** Linn. (Peela Hurhur)

A very common rainy season weed. It has an offensive odour. Seeds germinate by middle of July, flowers up to September. Flowers yellow. Plants remain stunted if dry spell prolongs.

2. **Gynandropsis gynandra** (Linn.) Merr. Syn. *G. pentaphylla* DC. (Safaid Hurhur)

A common weed, but not as common as *C. viscosa.* Seeds germinate with the first showers. It flowers by middle of August and is in fruit generally by the end of the same month. Flowers white.

VIOLACEAE

3. **Ionidium suffruticosum** Ging. Syn. *I. heterophyllum* Vent.

Not common, only collected from Hui Park. Seeds germinate with the early showers. It flowers from July to October. Flowers purplish pink. Fruit setting starts quite early.

PORTULACACEAE

4. **Portulaca oleracea** Linn. (Kulfa)

A common plant collected from Ramgarh Tal side. It flowers and fruits in July-August. Flowers yellow.

5. **Portulaca quadrifida** Linn.

It is a common weed in gardens and flower pots ; flowers in July-August.

MALVACEAE

6. **Abutilon indicum** G. Don. (Kakahi)

A common, almost perennial, plant flowering abundantly during the rains and up to December. Flowers yellow.

7. **Malvastrum coromandelinum** Garcke ; syn. *M. tricuspidatum* A. Gray. (Baryara)

Common ; collected from SAC (St. Andrew's College) and Hui Park, germinates in the rains, flowering quite early. Flowers yellow. Roots are used as an aphrodisiac, powdered and mixed with sugar ; Hindu women worship the plant because of this property.

8. **Sida acuta** Burm. f.

Not common, collected from Ramgarh Tal side under trees. Plants quite stout, flowering in September.

9. **Sida cordifolia** Linn.

Common in Hui Park. Seeds germinate late in rainy season. Flowers abundantly in October. Used for virility in man and stomach complaints.

10. **Sida grewioides** Guill.

Not common, collected from Hui Park. Leaves are small, orbicular, and yellowish green. It flowers late in the season.

11. **Sida veronicaefolia** Lamk. Syn. *S. humilis* Willd.

Not common, trailing, sometimes very long. It flowers abundantly in early September, produces fruit in September-October.

12. **Urena lobata** Linn.

Very common in Hui Park. Seeds germinate quite early, it flowers profusely in September-October. Before flowering it looks very similar to *Triumfetta* sp. Flowers pink.

13. **Urena repanda** Roxb.

Common in SAC and Hui Park. Not so high as the previous species. It flowers in September-October. Flowers whitish pink, mostly forming clusters at the top.

TILIACEAE

14. **Corchorus aestuans** Linn. Syn. *C. acutangulus* Lamk.

Common in SAC and Hui Park. Tallest and first to appear among the species of this genus collected here. More common in moist and shady places. It flowers August-October, forming 2-3 fruits about an inch long in each axil.

15. **Corchorus antichorus** Roensch.

Not very common, collected from Hui Park. Plants small ; leaves less than an inch long ; stems often prostrate with tortuous branches. Plants grow quite late and flower in September-October. Flowers yellow.

16. **Corchorus olitorius** Linn.

Not common, collected from Hui Park. It flowers September-October. Plants sometimes not much branched ; leaves 1½ inch long.

17. **Triumfetta bartramia** Linn. ; syn. *T. rhomboidea* Jacq.

Common in SAC and Hui Park. It is a large shrub-like annual with polymorphous 3-lobed leaves. Seeds germinate by middle of July, flowering starts together with fruiting by October. Fruits are hooked and round.

18. **Triumfetta rotundifolia** Lamk.

Common in Hui Park. Seeds germinate by late July, flowers and fruits in October-November. Smaller than the previous species. Fruits hooked but pointed.

ZYGOPHYLLEAE

19. **Tribulus terrestris** Linn. (Gokhru)

A prostrate herb with yellow flowers, collected from Domingarh and Aerodrome area. Not very common. Flowers and fruits in August. Powdered seeds are used for mouth blisters.

OXALIDACEAE

20. **Oxalis corniculata** Linn. (Tinpattia)

Very common in moist and shady places, annual or perennial. It flowers throughout the year, but more in rainy season.

21. **Oxalis acetosella** Linn. (Bari Tinpattia)

Rare, collected only from SAC. Larger than the previous species. Leaves are all radical. Seeds germinate in July and plants flower in August. Flowers purplish pink. Plants not very hairy. Not seen at other times of the year like the previous species.

VITACEAE

22. **Vitis trifolia** Linn. (Imirti)

A common climber at Ramgarh Tal side on the trees and in SAC. It sprouts abundantly by middle of July, flowers and fruits in September-November. Plants seem to sprout from a stout perennial rootstock.

SAPINDACEAE

23. **Cardiospermum halicacabum** Linn.

A slender climbing plant with thin and light green leaves. Flowers small and white. Common in Hui Park in early October, fruiting starts late in winter. Fruits are characteristically triangular with bladder and wings.

PAPILIONACEAE

24. **Abrus precatorius** Linn. (Ratti)

A common hardy twiner. Abundant seedlings come up in July. It flowers in August-September, and fruits during cold season. Seeds are poisonous.

25. **Aeschynomene aspera** Linn.

A marshy tall herb, collected from Asuran. Basal part of stem swollen and pith-like. It flowers abundantly late in the season. Flowers yellow.

26. **Alysicarpus monilifer** DC.

Commonly collected from Hui Park. Stem and leaves covered with hairs. Leaves simple. Flowers late in the season.

27. **Alysicarpus rugosus** DC.

A diffuse herb, common in Hui Park. Seeds germinate in July and plants flower till September.

28. **Argyrolobium roseum** Jaub. & Spach.

Collected near University cross-roads. Plants 1-2 feet in height. Seeds germinate late in the season. It flowers and fruits in November. Flowers yellow with brown streaks on petals. Inflorescence up to 10 inches long, in racemes.

29. **Clitoria ternata** Linn.

A common twiner. Seeds germinate with the first showers. It flowers profusely from August to October. Flowers blue.

30. **Crotalaria medicaginea** Lamk.

Collected from Hui Park only. Plants 1-1½ feet in height and much branched, silky hairy. Flowers in September-October, fruits late in October. Pods round and 2-seeded.

31. **Crotalaria prostrata** Roxb.

Not common, collected from Hui Park. A late rainy season weed. It flowers and fruits in November.

32. **Desmodium gangeticum** DC.

Very common in SAC and Hui Park. Seeds germinate by late July. It flowers abundantly in September-October. Fruits set in October-November. Flowers purplish pink and white.

33. **Desmodium pulchellum** Benth.

Not common ; shrub with downy branches. Flowers yellow,

34. **Desmodium triflorum** DC.

Very common. Prostrate, especially in fields and lawns. Flowers bright bluish purple. It continues to flower till late winter or even later.

35. **Indigofera enneaphylla** Linn.

Common. It flowers late in the season.

36. **Indigofera hirsuta** Linn.

A densely hairy plant, collected from Hui Park, 1-2 feet in height. Seeds germinate in August. Flowering starts in first week of September. Pink flowers crowded on racemes 2-3 inches long. Pods deflexed, densely pubescent, 4-gonous.

37. **Indigofera linifolia** Retz.

A much branched spreading herb, with simple leaves. Collected from Hui Park, not common. It flowers late in the season. Flowers red.

38. **Tephrosia purpurea** Pers.

A perennial undershrub, collected only at Domingarh. Sprouts up with rains. Seeds may also germinate at this time. It flowers abundantly in September and onwards. Flowers rose-coloured, in leaf-apposed racemes. It sets fruit soon.

39. **Uraria neglecta** Prain.

Rare ; collected only from Kusmi Forest, 1-2 feet in height, with one trifoliate leaf and racemose inflorescence. Flowers in July. Flowers yellowish purple. Characteristic fruits in one-seeded joints folded over one another.

40. **Zornia diphylla** Pers.

Not common, collected only from Hui Park. It has sub-erect slender stem. Leaves of two leaflets. Seeds germinate in August and flowers appear in September-October. Flowers yellow.

CAESALPINIACEAE

41. **Cassia absus** Linn.

Abundant in Hui Park only. Seeds germinate by middle of August. Plants about one foot in height, start flowering by early September and continue the whole month. Flowers are beautiful rose-red and not yellow. Stamens mostly four, unequal in size, and not five as mentioned in Duthie.

42. **Cassia occidentalis** Linn. (Bara Chakwad)

One of the commonest rainy season weeds on roadsides. Seeds germinate with the first showers, but the growth is slower than *C. tora.* Flowers in August-September. Flowers yellow.

43. **Cassia pumila** Lamk.

A common procumbent plant in Hui Park, with leaves 1-2 inches long, having 20-40 very small leaflets. Seeds germinate in August. It flowers in September-October. Flowers yellow. Stalked gland of petiole is characteristic.

44. **Cassia tora** Linn.

One of the commonest of rainy season weeds. Seeds germinate with the first rains. A number of seedlings grow close together. It starts flowering in late August and continues till September. Flowers yellow

45. **Mimosa pudica** Linn. (Lajwanti)

Cultivated and wild in Hui Park. It flowers abundantly in August.

LYTHRACEAE

46. **Ammannia baccifera** Linn.

Very common on moist margins of Ramgarh and Narhi tals and many other places. It flourishes well in swamps ; dry conditions are not congenial. It flowers mostly after rains and continues for a long period.

47. **Ammannia pygmaea** Kurz.

Very similar to previous species but very small. It flowers in rainy season, grows in dry situations also.

ONAGRACEAE

48. **Jussiaea repens** Linn.

Common in Ramgarh and Narhi tals, abundant at Asuran. Grows floating in water, showing very characteristic white respiratory spongy roots. Almost perennial, it grows on mud and even in dry land when water recedes. It flowers late in the season, and continues up to January and February. Flowers yellow.

49. **Jussiaea suffruticosa** Linn.

Not so common as *J. repens* collected from south margins of Ramgarh Tal and other places. Almost a perennial herb, which flourishes in water and shows spongy roots also. It flowers late in rainy season. Flowers yellow.

50. **Ludwigia parviflora** Roxb.

Rare, collected only from Asuran. A prostrate herb which grows near water. It flowers in December. Flowers small and yellow.

51. **Trapa bispinosa** Roxb. (Singhara)

An aquatic plant of economic importance which grows in seasonal pools. Seedlings planted in July. Plants flower abundantly in August and fruit in September-October.

CUCURBITACEAE

52. **Coccinia indica** W. & A. Syn. *Cephalandra indica* Naud. (Kala Jeur, Kundru)

A common climber ; plants spread abundantly by late July, and profusely flower in August-September. They bear more male than female flowers. Flowers white, fruits red when ripe. Leaves and roots are crushed and used in diabetes.

53. **Cucumis trigonus** Roxb. (Ghurma)

A trailing plant collected from Kusmi Forest, with small yellow staminate flowers. It flowers in August-September. Fruits with green and white stripes, becoming yellow when ripe.

MOLLUGINACEAE

54. **Trianthema portulacastrum** Linn. Syn. *T. monogyna* Linn.

Very common. Seeds germinate with the first showers. It flowers abundantly from August to October, as long as conditions are wet.

55. **Glinus lotoides** Linn. Syn. *Mollugo lotoides* O. Kze. and *M. hirta* Thunb.

Plants collected from drying ponds in low-lying areas after rains. A hairy prostrate herb. Leaves opposite or whorled. It flowers late in the season.

56. **Mollugo stricta** Linn.

Not common, collected from Kusmi Forest. It flowers by middle of August till September. Fruiting starts quite early.

RUBIACEAE

57. **Dentella repens** Forst.

A prostrate slender herb, common near Ramgarh Tal and Domingarh wayside ponds. Seeds germinate quite early in June-July. The plant is so small and insignificant that it can easily be overlooked. It flowers abundantly by late July. Flowers small and white.

58. **Oldenlandia crystallina** Roxb.

Not very common; collected from Hui Park. Seeds germinate in late July and flower by the end of August. It is smaller than *O. dichotoma.* Flowers are small in pairs on long thin pedicels in the axils of leaves.

59. **Oldenlandia dichotoma** Hook.

Very common in Hui Park and in SAC. It grows profusely in fields by September-October, and flowers soon after. A much larger species.

60. **Spermacoce hispida** Linn. (Gidni)

A procumbent annual, collected from Kusmi Forest and Hui Park. Plants are sufficiently big by late August, and flowering starts soon after. Flowers are produced in axillary clusters. Not common. Flowers purplish blue. Roots after powdering are applied on breast abcesses and ulcers.

COMPOSITAE

61. **Ageratum conyzoides** Linn.

A very common, softly hairy annual; springs up in abundance soon after rains in July-August: it is 6-16 inches in height. It flowers in September. This plant flourishes well in shady and moist ground. Flowers purplish white.

62. **Bidens pilosa** Linn.

Common, 10-20 inches in height, collected from Hui Park. It flowers in September-October.

63. **Caesulia axillaris** Roxb.

Not very common, collected by the side of a stream on way to Tilonia Forest range. It flourishes in swamps, and flowers late in the season. Flowers greyish white in the axils of long sessile leaves.

64. **Chrysanthemum indicum** DC.

A procumbent small diffuse herb. Heads are small. The plant commonly grows on roadside shady places, and flowers late in the season. Flowers yellow.

65. **Eclipta prostrata** Linn. Syn. *E. alba* Hassk., *E. erecta* Linn. (Bhangraia)

An erect or prostrate herb, common, but abundant only in moist soil. It flowers in rainy season and later. Flowers white. The leaves are used for hair dye, and are an important ingredient in medicated oils. Leaf extract is used in ear-ache and also in boils etc. Latex is used for tattooing.

66. **Tridax procumbens** Linn.

Common. Seen almost throughout the year, but more prominent in the rainy season. It flowers late in the season and continues till winter. Flowers light yellow.

67. **Xanthium strumarium** Linn. (Gokhroo)

Common all over for most of the year. Seedlings seen at Kusmi Forest in the middle of August. In other places plants were collected in flower and fruit. Not strictly a rainy season weed.

APOCYNACEAE

68. **Ichnocarpus frutescens** Br.

A large shrubby twiner, not very common. Flowering in August-September for a comparatively short time.

69. **Tabernaemontana coronaria** Willd. Syn. *Ervatamia coronaria* Stapf. (Chandni)

An ornamental shrub, become wild all over. It flowers in August to October. Leaves are shining green, flowers white.

ASCLEPIDACEAE

70. **Pergularia pallida** Wt. & Arn.

A twining shrub, collected from SAC, climbing on hedges. It grows in July and flowers abundantly with yellowish white coloured umbellate cymes. Pollinia waxy with reddish brown translator. Not seen elsewhere.

BORAGINACEAE

71. **Heliotropium indicum** Linn.

Hairy plants, common. Seeds germinate in May-June, and flower soon after. Fruits are produced abundantly in July-August. Flowers pale violet. Fruits characteristic with one-seeded pyrenes.

72. **Heliotropium ovalifolium** Forsk.

Erect, decumbent or prostrate, densely clothed with hairs; collected from Domingarh and SAC. Seeds germinate very early ; fruiting abundant in July. There are invariably 4 sepals in the specimens collected, which is different from other records.

73. **Heliotropium subulatum** Hochst.

Erect, the largest in the genus : collected from Domingarh and SAC. It grows on comparatively dry soil. Plants are seen very early in the season and continue to flower after rainy season. A common plant.

74. **Heliotropium supinum** Linn.

Villous herbs, common on roadside in moist shady places. Seeds germinate very early in June-July. The plant flowers and fruits by early August. From a distance the plant looks very similar to *Salvia plebeia*.

75. **Heliotropium strigosum** Willd.

A small much-branched procumbent herb, growing abundantly in rains in playground near SAC Hostel. Seeds germinate with the first rains, the plant flowers profusely by the end of July. Flowers small and white. Not common.

CONVOLVULACEAE

76. **Evolvulus nummularis** Linn.

Very common, much-branched creeping perennial herb in fields at SAC, Domingarh, and other places, on comparatively dry and hard soil. It sprouts with the first showers after hot summer, although the plant is met with throughout the year. White small flowers are abundantly produced from July to October. Flowering is withheld for the winter months, and it appears again in April, but the plants do not look fresh.

77. **Evolvulus alsinoides** Linn.

A diffuse hairy herb, not common. It is a strict rainy season weed, collected after rains in July from SAC and Hui Park. Seeds germinate with early rains, and flower in August-September. Plants are not seen late in the season. Flowers light blue on comparatively long pedicels.

78. **Ipomoea aquatica** Forsk. Syn. *I. reptans* Poir. (Karmua)

An aquatic or semi-aquatic herb, which flourishes on swampy and moist margins of ponds etc. It flowers in late rainy season, and continues flowering till the ground is completely dry. Plants are supposed to be effective for stomach disorders.

79. **Ipomoea pes-tigridis** Linn.

Not very common. A small twining herb, collected only from Hui Park. Seeds germinate late in August. Leaves and stem fulvous hairy. It flowers in September-October and finishes soon after. Flowers purplish.

80. **Ipomoea sindica** Stapf.

A late rainy season weed, collected only from Hui Park in guava orchard twining over grasses etc. Stems many from the base, prostrate, slender and hispid. Leaves hastate, up to 2 inches long. It flowers in October-November, and finishes soon after.

81. **Porana paniculata** Roxb. (Safaid Bel)

A large climbing shrub, only recorded from Afaq Park. It does not appear to be wild. It flowers in October-November, with numerous small white flowers, arranged in large axillary, terminal drooping panicles.

SOLANACEAE

82. **Datura fastuosa** Linn. (Dhatura)

A wild form not very common, small and shrubby. It flowers late in rainy season and afterwards. Seeds are used in asthma. Seeds boiled in oil are used for gout ; they are also smoked for intoxication.

83. **Datura stramonium** Linn.

Annual. Seeds germinate in late July, collected from Domingarh. It flowers late in the season till winter. Flowers white.

84. **Nicotiana plumbaginifolia** Viv. (Jungli Tamakhu)

Common in fields and SAC. Seeds germinate in early July. Leaves radical and cauline, the latter lanceolate. Stems 6-12 inches in height. It flowers abundantly from July to October, and then again in April. Flowers purplish white. No mention of this plant in Duthie.

85. **Physalis minima** Linn. (Ban Makoi)

Common. Seeds germinate with the rains. Flowering starts by August and continues till late in the season. Flowers yellowish white.

86. **Solanum xanthocarpum** Schrad & Wendl. (Bhaktoi)

Not strictly a rainy season weed, but flourishes well in rains and starts flowering. Collected from roadside near aerodrome in middle of July. Flowers abundantly in December. Water, in which leaves are boiled, is given for fever. Seeds, after keeping on red hot earthen pot, give out fumes which are inhaled for carious teeth.

SCROPHULARIACEAE

87. **Bonnaya brachiata** Link & Otto.

Not common. Collected from moist and shaded spots near Ramgarh Tal and SAC. Seeds germinate with the early showers. Plants 3-8 inches in height, leaves spinose-serrate and glabrous. It starts flowering by the end of July and continues till the end of the season. Flowers purple and white.

88. **Bonnaya veronicaefolia** Spreng.

A common decumbent herb collected from shaded spots in Hui Park and SAC. Small plants, like the previous species. Seeds germinate in August and flower during the whole rainy season and continue till late winter in places. Leaves sub-entire or with distantly serrate margins. Flowers purplish white.

89. **Limnophila gratioloides** R. Br.

Grows in water or in swamps ; collected from Asuran. Plants show heterophylly. Pinkish coloured flowers are produced abundantly in September-October. It continues to flower and produce fruits till late in the season.

90. **Mazus rugosus** Lour.

Very common small glabrous annual with tufted stems ; at SAC and other places. It grows late in the season, and flowers throughout winter. Flowers purplish white.

91. **Moniera cuneifolia** Mich.

From the records of Prof. M. O. Varkey, who collected it on 10-10-1946, but not recorded by the author.

92. **Scoparia dulcis** Linn.

Common. It does not seem to be a true plant of this season, possibly the rootstock sprouts in rains. Flowers white.

LENTIBULARIACEAE

93. **Utricularia flexuosa** Vahl.

A very common aquatic plant, which flourishes well in Asuran Poklhra, Bitia ponds, and others. It starts flowering in early winter and not in hot season as mentioned in Duthie. Flowers yellow.

94. **Utricularia stellaris** Linn.

Not common. Collected from a roadside pond on way to Domingarh. Inflorescence is held up above the water by a whorl of 4 floats on the peduncle, with yellow flowers. It flowers in early winter.

PEDALIACEAE

95. **Martynia diandra** Glox. (Bichhu, Kaua)

From the records of Prof. M. O. Varkey, who collected it on 27-9-1946. Fruits characteristic with 2 hard curved spines. It flowers during and after rains.

96. **Sesamum indicum** Linn. (Tilli)

An erect annual herb, common in Hui Park and many other places, 1-2 feet in height. It germinates in August and flowers in September. Flowers bilabiate and pinkish purple.

ACANTHACEAE

97. **Adhatoda vasica** Nees. Syn. *Justicia adhatoda* Linn. (Adhus)

Very common shrub. Rootstock sprouts up in rains. It starts flowering in early winter and continues onwards. Flowers large and white. Leaves are made use of in ripening of fruits by covering the latter with them. Leaves oil-smeared and warm are kept on wounds, etc.

98. **Aechmanthera tomentosa** Nees.

From the notes of Prof. M. O. Varkey who collected it on 28-8-1945, and recorded that the plant is not hairy, as mentioned in Duthie, has no bracteoles, and also ovary is not so hairy. Not recorded by the author.

99. **Andrographis paniculata** Nees. (Kalmegh, Kalpnath)

Common ; grows and flowers late in the season by October to December. Flowers pink. Leaf extract after boiling is used as blood purifier.

100. **Barleria strigosa** Willd.

An unarmed shrub, cultivated and wild, not common as a weed. Seeds germinate with late rains ; it flowers for a short period in early winter. Flowers blue.

101. **Hygrophila polysperma** T. Anders.

Common near margins of ponds and ditches, collected from Domingarh and a number of other places. It flowers abundantly in September-October and continues till winter season. Flowers pinkish white. Stamens two, and not four as mentioned in Duthie.

102. **Justicia procumbens** Linn. Syn. *J. diffusa* Willd.

A diffuse much-branched herb ; not very common, collected near Rani ka Pokhra. Seeds germinate with rains, flowers in September-October. Plants are not seen after November. Flowers purplish pink.

103. **Peristrophe bicalyculata** Nees.

Very common in waste land after rains. Stem characteristically 6-angled. It flowers late in the season and early winter. Flowers pink. Crushed plants mixed with pepper are given in fever.

104. **Ruellia patula** Jacq.

A small hoary pubescent plant, collected from Hui Park and Domingarh. Not common ; flourishes during the rains only. It flowers rather sparsely in late August. Plants do not live very long.

105. **Thunbergia grandiflora** Roxb.

Not common, mostly cultivated. Plants come up with rains, flower abundantly in September-October. It is a climber with large and showy flowers. Flowers light blue.

VERBENACEAE

106. **Lippia nodiflora** Rich. (Bukkam)

Common near water and other places. It flowers throughout, but more so in July, with shining spikes of violet colour. Fruits are also formed at the same time. Plants, especially leaves, after crushing are applied on forehead for headache.

107. **Verbena officinalis** Linn.

An erect herb, collected from Ramgarh Tal side and Bitia. Spikes are 4-6 inches long. It flowers late in July till August. Flowers lilac.

LABIATAE

108. **Anisomeles indica** O. Kze. Syn. *A. ovata* R. Br.

Plants 3-6 feet in height, densely pubescent ; collected from Hui Park. This is more common towards the west of Gorakhpur on the sides of railway line. It grows late in September, and flowers by October. Plants form seeds and die off by middle of November.

109. **Leucas cephalotes** Spreng. (Gom)

Plants appear by early August ; they are soft and hairy, the leaves long and serrate. Inflorescence globose, about ¾ inch in diameter. It flowers by August-September. Flowers white. Crushed leaves are put in the nostrils for cold and applied on forehead for headache.

110. **Leucas lavandulaefolia** Rees. Syn. *L. linifolia* Spreng.

Not common ; collected from Kusmi Forest ; about 1 foot in height. Leaves linear lanceolate. It flowers in August-September. Flowers white.

111. **Leonurus sibiricus** Linn.

Not common, collected near University cross roads. About 4 feet in height, the plant flowers in early November. Flowers bluish pink.

112. **Plectranthus coetsa** Buch.-Ham.

From the records of Prof. M. O. Varkey who collected it on 27-9-1946, but not recorded by the author.

113. **Leonotis nepetaefolia** R. Br.

Not very common ; collected from Hui Park. Seeds germinate by early October. It flowers in November. Flowers yellowish orange. Not recorded by Kanjilal.

114. **Ocimum americanum** Linn. Syn. *O. canum* Sims. (Tulsi)

Common, collected near University cross roads. Leaves 1 inch long, gland-dotted on lower surface. It grows in October, flowers early November.

NYCTAGINACEAE

115. **Boerhavia diffusa** Linn. (Gajphunna)

One of the commonest perennial weeds which flourishes in rains, spreading and trailing on ground. It flowers by July to September. Plants look dull in winter, they flower again though not so profusely in March-April. Flowers pink. Roots are boiled and given in fever.

AMARANTHACEAE

116. **Achyranthes aspera** Linn. (Chitchita)

Very common ; grows in August-September, and flowers late in the season and onwards.

117. **Alternanthera sessilis** (Linn.) DC.

A prostrate herb, common near ponds and ditches. It produces white and shining axillary heads. Plants grow in July and flower late in the season.

118. **Amaranthus polygamous** Linn.

A rare plant, collected from Ramgarh Tal side. It grows with rains and flowers in September.

119. **Amaranthus spinosus** Linn. (Jungli Chaulai)

A very common spiny annual. It grows with the early rains and flowers soon after. It is bigger than *A. viridis.* A troublesome weed, whose stem is often tinged with red.

120. **Amaranthus viridis** Linn. (Chaulai)

An erect much-branched annual 1-2 feet in height. Not so common as the previous species. It grows with the rains and flowers soon after.

121. **Gomphrena globosa** Linn.

An annual herb, not common : collected only near Domigarh railway station by the side of the rails. Inflorescence globose of white silky heads. It flowers in September.

122. **Nothosaerua brachiata** Wight.

An erect slender herb, collected near Ramgarh Tal and Bitia side. It is more common in wet places. It flowers in July-August.

POLYGONACEAE

123. **Polygonum hydropiper** Linn. (Pani Mirch)

An aquatic or semi-aquatic plant, collected from Ramgarh Tal side. The stem is branched and swollen at nodes. It flowers in July. Flowers pink.

124. **Polygonum glabrum** Willd.

An aquatic or semi-aquatic plant, common in Ramgarh Tal. Inflorescence 2-4 inches long. Flowers abundantly by late July till September, opening of flowers is irregular. Flowers pink.

125. **Antigonon leptopus** Hook. et Arn.

Commonly cultivated in hedges, but becomes wild on roadsides. It flowers abundantly in late rainy season. Flowers pinkish rose. Not recorded by Duthie.

PIPERACEAE

126. **Peperomia pellucida** H.B.K.

A rare succulent annual, collected only from Hui Park. Seeds germinate in August. Stems sometimes rooting at nodes. It flowers abundantly at a young stage by August-September.

EUPHORBIACEAE

127. **Acalypha indica** Linn. (Fursh Buti)

An erect annual, common. Plants grow in July, and start flowering in early August and continue later. Leaf extract is taken in cow's milk for strength.

128. **Chrozophora rottleri** A. Juss.

Very common near Bitia side, it grows in summer and flowers abundantly in rainy season. Male flowers yellow.

129. **Croton sparsiflorus** Morong.

One of the commonest weeds on roadsides. Has a repulsive smell. It grows throughout the year, but flourishes well in rainy and cold seasons. Not recorded by Duthie.

130. **Euphorbia hirta** Linn. (Bari Dudhi)

A small prostrate herb with erect branches and opposite leaves. Common, almost throughout the year. It flowers for a considerable part of the year.

131. **Euphorbia thymifolia** Linn. (Chhoti Dudhi)

Very common on gravel paths. Seeds germinate with the rains ; plants change from a green to coppery hue, and flower for a long time in the season. Leaf extract is given in mother's milk to infants suffering from dysentery.

132. **Phyllanthus niruri** Linn.

Grows very early in the rainy season, a true rainy season weed, very common. Flowering starts by late July. Flowers are very small and axillary.

133. **Phyllanthus simplex** Retz.

A glabrous herb, common in Hui Park. Plants appear quite early in the season. Flowers are solitary on stout long pedicels, capsule rough but not echinulate. It flowers in July-August and fruits set in soon after.

134. **Phyllanthus urinaria** Linn.

A common small weed, collected from Hui Park and SAC. Plants look very similar to *P. niruri*, but they are smaller and dark green in colour. It flowers in August-September. Fruits are faintly echinulate.

URTICACEAE

135. **Cannabis sativa** Linn. (Bhang)

Very common, mostly on southern side. It sprouts up abundantly with rains, and grows till late winter. It flowers in early winter.

136. **Fleurya interrupta** Gaud. (Bichhu)

Rare ; collected only from SAC campus. It grows in August and flowers soon after. It does not live very long.

137. **Pouzolzia indica** Gaud.

It has not been recorded except from SAC ; collected together with *Fleurya interrupta*. Seeds germinate with the early rains, flower till September. A rare plant.

ORCHIDACEAE

138. **Vanda roxburghii** R. Br.

Not very common, collected from Turra Nulla. It is an epiphyte, and flowers by middle of August. Flowers yellowish cream.

SCITAMINACEAE

139. **Globba** sp.

Very common in Hui Park all along the boundary. It grows with rains and flowers profusely in August. Flowers purplish red. It looks like a canna.

DIOSCOREACEAE

140. **Dioscorea sativa** Linn.

A climbing plant, collected from Hui Park. It flowers late in August, in drooping spikes. Not common.

PONTEDERIACEAE

141. **Monochoria vaginalis** Persl.

An aquatic plant ; flowers commonly in rainy season. It is common in Ramgarh Tal.

COMMELINACEAE

142. **Murdannia nudiflorum** Linn. Syn. *Aneilema nudiflorum* R.Br.

A common slender weed, collected from Hui Park and SAC; grows by early August. Leaves 1-2 inches long ; inflorescence is a panicle on a scape. It flowers by late August and early September for a short time.

143. **Commelina benghalensis** Linn.

Common near moist margins of ditches and in low-lying areas. It flowers abundantly during the rains.

144. **Commelina nudiflora** Linn.

Very common near bathrooms of SAC Hostel and Ramgarh Tal side ; grows by early July. Plants are bigger in size than the previous species, leaves broad and sessile. Flowering starts by early August and continues till September. Flowers blue. Leaf extract is applied in wasp stings.

145. **Cyanotis axillaris** Schult.

Rare ; collected from Hui Park in shade. Leaves 2-3 inches long and linear. Inflorescence axillary in helicoid cymes. Stamens have bearded filaments, anthers are yellow.

146. **Cyanotis cristata** Schult.

Rare ; collected only from Domingarh near old buildings on a wall ; looks very similar to *Commelina* sp. Flowers abundantly by the first week of September for a short time ; stamens six with bearded filaments.

NAIADACEAE

147. **Aponogeton monostachyon** Linn. f.

An aquatic plant collected from Domingarh in August-September, when it flowers abundantly. White flowers emerge out of the water surface.

INCIDENCE OF FREQUENCY ABUNDANCE REGARDING GROWTH AND PHENOLOGY OF WEEDS DURING RAINY SEASON—1958

In the following chart the monthly incidence of frequency-abundance regarding growth and phenology of rainy season weeds is given. The symbols used are : R-rare (1-5) ; F-frequent (5-15) ; C-common (50-100) : A-abundant (100-200) : D-dominant (over 200). The numbers within brackets are the approximate numerical values of the symbols for the localities from which the plants have been collected as mentioned in the case of each plant. v and l are used as prefix for ' very ' and ' local '.

Plant species	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. *Cleome viscosa* Linn.	D	A	A	F	..	..
2. *Gynandropsis gynandra* (Linn.) Merr.	lA	lC	F	F	..	..
3. *Ionidium suffruticosum* Ging.	R	vF	C	F	..	..
4. *Portulaca oleracea* Linn.	vF	vF	F	..	..	..
5. *P. quadrifida* Linn.*	..	..	*	..	..	..
6. *Abutilon indicum* G. Don	lF	F	F	C	F	F
7. *Malvastrum coromandelinum* Garcke.	lF	lF	lF	F	F	..
8. *Sida acuta* Burm. f.	..	..	lF	lF	..	..
9. *S. cordifolia* Linn.	..	F	C	lA	A	..
10. *S. grewioides* Guill.	..	F	vF	C	F	..
11. *S. veronicaefolia* Lamk.	..	..	vF	F	..	..
12. *Urena lobata* Linn.	C	C	lA	lA	C	..
13. *U. repanda* Roxb.	..	lF	lC	lA	F	..
14. *Corchorus aestuans* Linn.	F	C	C	C	F	..
15. *C. antichorus* Roensch.	..	F	F	F	..	..
16. *C. olitorius* Linn.	..	..	F	F	..	..
17. *Triumfetta bartramia* Linn.	R	F	C	C	F	..
18. *T. rotundifolia* Lamk.	..	F	F	C	vC	..
19. *Tribulus terrestris* Linn.	lR	lR	..	..	..	..
20. *Oxalis corniculata* Linn.	lF	lF	lF	lF	lF	..
21. *O. acetosella* Linn.	lF	lC	lR	..	..	..
22. *Vitis trifolia* Linn.	lF	lC	lC	lC	lF	..
23. *Cardiospermum halicacabum* Linn.	..	..	lF	lF	lF	..
24. *Abrus precatorius* Linn.	..	lF	lF	..	..	..
25. *Aeschynomene aspera* Linn.	..	..	lF	lF	lF	lF
26. *Alysicarpus monilifer* DC.	..	..	..	lF	lF	..
27. *A. rugosus* Linn.	lR	lF	lC	lR	..	..
28. *Argyrolobium roseum* Jaub & Spach.	..	..	..	lR	lF	..
29. *Clitoria ternatea* Linn.	lF	lA	lA	lF	lF	..
30. *Crotalaria medicaginea* Lamk.	..	lF	lC	lA	lF	..
31. *C. prostrata* Roxb.	..	..	..	lF	lF	..
32. *Desmodium gangeticum* DC.	F	C	vA	C	..	..
33. *D. pulchellum* Benth.	..	..	lR	lR	..	..
34. *D. triflorum* DC.	..	A	A	A	A	A
35. *Indigofera enneaphylla* Linn.	..	..	..	F	F	F
36. *I. hirsuta* Linn.	..	R	C	C	..	..
37. *I. linifolia* Retz.	..	F	C	C	..	..
38. *Tephrosia purpurea* Pers.	F	F	C	C	F	F
39. *Uraria neglecta* Prain.	lR	lR	..	..	..	..
40. *Zornia diphylla* Pers.	..	lR	lF	lF	..	..
41. *Cassia absus* Linn.	..	C	vC	A	..	..
42. *C. occidentalis* Linn.	vA	D	D	vA	C	..
43. *C. pumila* Lamk.	..	lF	lC	lA	..	..
44. *C. tora* Linn.	F	vC	vC	F	..	..
45. *Mimosa pudica* Linn.	F	F	C	C	..	..
46. *Ammania baccifera* Linn.	C	A	A	A	C	

Plant species	July	Aug.	Sept.	Oct.	Nov.	Dec.
47. *A. pygmaea* Kurz.	C	C	C	C	F	F
48. *Jussiaea repens* Linn.	F	F	F	F	F	..
49. *J. suffruticosa* Linn.	R	F	F	R	..	..
50. *Ludwigia parviflora* Roxb.	..	lR	lR	lR	..	..
51. *Trapa bispinosa* Roxb.	C	A	A	A	F	R
52. *Coccinia indica* W. & A.	F	C	C	C	..	..
53. *Cucumis trigonus* Roxb.	F	F	F	R	..	..
54. *Trianthema portulacastrum* Linn.	vC	A	A	A	vC	..
55. *Glinus lotoides* Linn.	lF	lF	F	F	..	..
56. *Mollugo stricta* Linn.	..	R	R	..	..	..
57. *Dentella repens* Forst.	C	A	vC	F	..	..
58. *Oldenlandia crystallina* Roxb.	..	F	vF	..	..	..
59. *O. dichotoma* Hook.	..	F	C	vC	F	..
60. *Spermacoce hispida* Linn.	..	F	C	F	..	..
61. *Ageratum conyzoides* Linn.	C	vC	lA	lA	C	C
62. *Bidens pilosa* Linn.	..	..	F	F	..	..
63. *Caesulia axillaris* Roxb.		..	F	F	..	..
64. *Chrysanthemum indicum* DC.	..	..	F	F	..	..
65. *Eclipta prostrata* Linn.	C	A	A	A	C	C
66. *Tridax procumbens* Linn.	C	C	C	C	F	F
67. *Xanthium strumarium* Linn.	F	F	F	F	F	F
68. *Ichnocarpus frutescens* Br.	..	F	C	F	..	..
69. *Tabernaemontana coronaria* Willd.	..	F	C	F	..	..
70. *Pergularia pallida* W. & A.	lR	lR	lF	lF	..	..
71. *Heliotropium indicum* Linn.	vF	vF	lF	lF	..	..
72. *H. ovalifolium* Forsk.	F	F	F	F	F	..
73. *H. subulatum* Hochst.	C	vC	vC	C	C	F
74. *H. supinum* Linn.	C	C	vC	C	C	C
75. *H. strigosum* Willd.	lA	lA	lA	lC	..	..
76. *Evolvulus nummularius* Linn.	A	vA	vA	C	F	F
77. *E. alsinoides* Linn.	R	F	F	R	..	..
78. *Ipomoea aquatica* Forsk.	F	F	F	F	F	F
79. *I. pes-tigridis* Linn.	..	F	vF	F	..	..
80. *I. sindica* Stapf.	..	..	F	F	..	..
81. *Porana paniculata* Roxb.	..	..	lC	lA	..	..
82. *Datura fastuosa* Linn.	..	F	F	F	..	..
83. *D. stramonium* Linn.	..	F	F	F	..	..
84. *Nicotiana plumbaginifolia* Viv.	vF	C	C	vF	..	..
85. *Physalis minima* Linn.	F	C	vC	C	..	..
86. *Solanum xanthocarpum* Schr. et Wendl.	lF	lF	..	..	F	vC
87. *Bonnaya brachiata* Link & Otto.	vC	vC	vC	vF	F	..
88. *B. veronicaefolia* Spreng.	vC	vC	A	vC	vF	F
89. *Limnophila gratioloides* R.Br.	lC	lA	lA	lD	lA	..
90. *Mazus rugosus* Lour.	..	..	F	vC	A	C
91. *Moniera cuneifolia* Mich.*	..	..	..	*	..	..
92. *Scoparia dulcis* Linn.	F	F	F	F	F	F
93. *Utricularia flexuosa* Vahl.	..	..	..	F	C	vC
94. *U. stellaris* Linn.	..	..	..	lF	lF	..
95. *Martynia diandra* Glox.*	..	..	*	..	..	..
96. *Sesamum indicum* Linn.	..	F	vF	C	F	..
97. *Adhatoda vasica* Nees.	R	..	..	..	F	C
98. *Aechmanthera tomentosa* Nees.*	..	*	..	..	..	..
99. *Andrographis paniculata* Nees.	..	R	F	C	vC	F
100. *Barleria strigosa* Willd.	..	..	vF	C	C	..
101. *Hygrophila polysperma* T.Anders.	F	C	vC	A	vC	vC
102. *Justicia procumbens* Linn.	..	C	C	C	..	..
103. *Peristrophe bicalyculata* Nees.	R	F	C	vC	C	F
104. *Ruellia patula* Jacq.	F	F	F	F	..	..
105. *Thunbergia grandiflora* Roxb.	..	F	F	F	..	..

Plant species	July	Aug.	Sept.	Oct.	Nov.	Dec.
106. *Lippia nodiflora* Rich.	C	C	C	F	..	..
107. *Verbena officinalis* Linn.	C	F	F	..	..	..
108. *Anisomeles indica* O.Kze.	..	..	F	C	C	F
109. *Leucas cephalotes* Spreng.	F	vF	C	F	..	..
110. *L.lavandulaefolia* Rees.	R	F	F	F	..	..
111. *Leonurus sibiricus* Linn.	..	..	F	vF	..	..
112. *Plectranthus coetsa* Buch.-Ham.*	..	..	*	..	..	..
113. *Leonotis nepetaefolia* R.Br.	..	..	F	C	C	C
114. *Ocimum americanum* Linn.	..	..	F	F	F	..
115. *Boerhavia diffusa* Linn.	A	D	vA	C	F	..
116. *Achyranthes aspera* Linn.	..	R	F	vF	C	C
117. *Alternanthera sessilis* (Linn.) DC.	C	C	C	C	C	C
118. *Amaranthus polygamous* Linn.	R	R	R	..	..	..
119. *A. spinosus* Linn.	vC	A	D	A	C	..
120. *A. viridis* Linn.	C	C	vC	C	..	..
121. *Gomphrena globosa* Linn.	..	R	R	..	..	..
122. *Nothosaerua brachiata* Wight.	vF	C	C	..	..	..
123. *Polygonum hydropiper* Linn.	vF	vF	F	..	..	..
124. *P. glabrum* Willd.	vF	C	vF	F	..	..
125. *Antigonon leptopus* Hook et Arn.	..	R	F	C	vC	..
126. *Peperomia pellucida* H.B.K.	..	lF	lC	lF	..	..
127. *Acalypha indica* Linn.	F	F	vF	C	C	vF
128. *Chrozophora rottleri* A.Juss.	vF	F	..	..	..	..
129. *Croton sparsiflorus* Morong.	A	A	A	A	C	C
130. *Euphorbia hirta* Linn.	A	A	A	A	vC	F
131. *E. thymifolia* Linn.	A	A	A	vC	vC	..
132. *Phyllanthus niruri* Linn.	C	vC	vC	C	..	..
133. *P. simplex* Retz.	C	vC	vC	..	..	..
134. *P. urinaria* Linn.	..	F	C	C	..	..
135. *Cannabis sativa* Linn.	lF	lF	lF	lF	lF	lF
136. *Fleurya interrupta* Gaud.	lF	lC	lC	lF	..	..
137. *Pouzolzia indica* Gaud.	lF	lC	lC	lF	..	..
138. *Vanda roxburghii* R.Br.	F	C	C	F	..	..
139. *Globba* sp.	lC	lC	lF	..	..	..
140. *Discorea sativa* Linn.	..	F	F	F	..	..
141. *Monochoria vaginalis* Persl.	F	F	F	F	..	..
142. *Murdannia nudiflorum* Linn.	..	C	vC	F	..	..
143. *Commelina benghalensis* Linn.	F	vF	vF	F	..	..
144. *C. nudiflora* Linn.	vC	A	A	vC	C	..
145. *Cyanotis axillaris* Schult.	R	R	R	..	..	..
146. *C. cristata* Schult.	..	lF	lC	lF	..	..
147. *Aponogeton monostachyon* Linn.f.	lF	lC	lF	lR	..	..

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On some new Species of Spiders (Arachnida) of the Family Thomisidae from India

BY

B. K. TIKADER

(With seven text-figures)

INTRODUCTION

Spiders of the family Thomisidae have received scant attention in India. THE FAUNA OF BRITISH INDIA, ARACHNIDA (1900) contains no reference to this family. Only Stoliczka (1869) and Dyal (1935) described a few new species in the genus *Thomisus.*

While examining the material of spiders preserved in the Zoological Survey of India, I came across several new species of Thomisid spiders, some of which are described elsewhere. The present paper contains descriptions of seven new species. The type specimens are deposited in the Zoological Survey of India, Calcutta.

Xysticus minutus sp. nov. (Fig. 1)

General: Cephalothorax light brown; eyes black, clypeus white, legs greenish, abdomen light brown. Total length 2.20 mm.; carapace 1.00 mm. long, 1.00 mm. wide; abdomen 1.30 mm. long, 1.20 mm. wide.

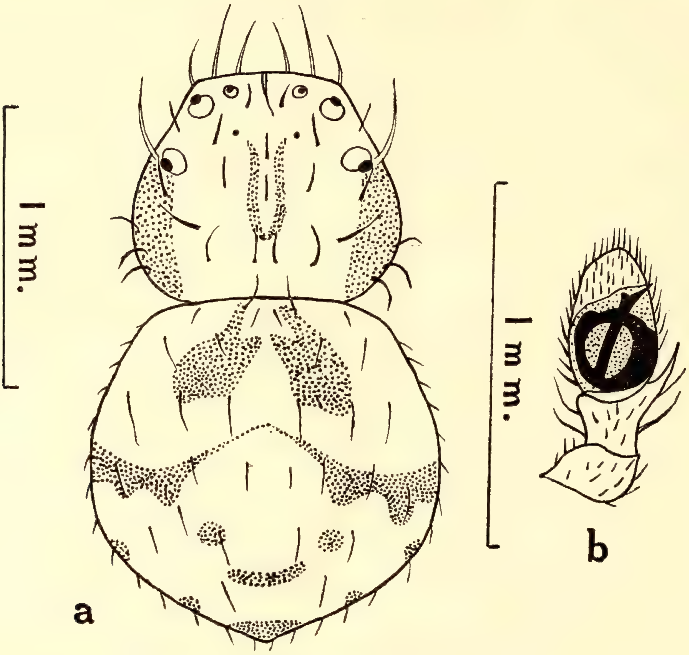
Cephalothorax as long as wide, spined, the sides with broad longitudinal dark brown patches, a pair of long paler brown irregular lines from the base of posterior median eyes, extending to the middle of the thorax. Clypeus medium, margin with seven strong spines, directed forward but the median directed upward. Eyes round, ringed with dirty-white tubercles; ocular quad slightly wider than long, space of the anterior median eyes a little wider than that of posterior; lateral eyes larger; posterior median eyes smaller than anterior medians. Legs spined, with brown transverse bands, tibiae I and II with two pairs of ventral spines. The apex of tibiae I and II with broad dark brown patches.

Abdomen oval, dorsum spined, slightly overlapping the posterior region of cephalothorax, dorsal surface with dentated bands beautifully coloured with admixture of white, dark brown, and red.

Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-4-1958.

This species is closely related to *Xysticus ferox* (Hentz) but differs as follows: (i) sides of cephalothorax with longitudinal dark brown broad patches and a pair of long pale brown irregular lines from the base of anterior median eyes to the middle of thorax, but in *X. ferox* the cephalothorax is yellowish in the middle and reddish-brown on the sides; (ii) Abdomen light brown, with dentated bands beautifully coloured with admixture of white, dark brown, and red, but in *X. ferox* abdomen brownish-grey above and smoky-white on the sides and three pairs of transverse black bars on the dorsal side of the abdomen.



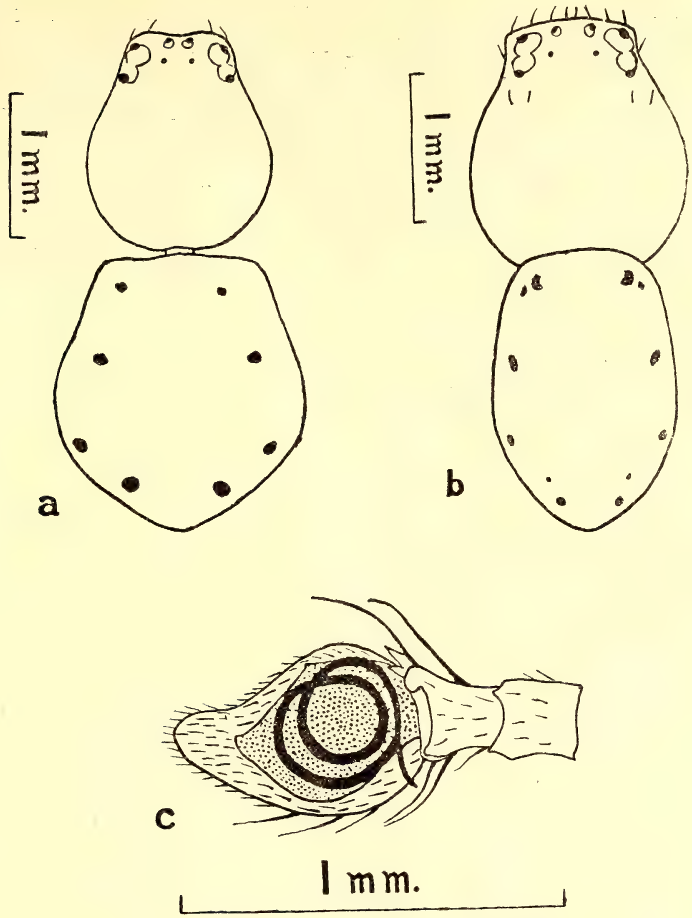
Text-fig. 1. *Xysticus minutus* sp. nov.

(a) Dorsal view of whole body; (b) male pedipalp.

Synaema decorata sp. nov. (Fig. 2)

General: Cephalothorax green, ocular tubercles chalk-white, eyes black; legs and abdomen green. Total length 3.40 mm.; carapace 1.40 mm. long, 1.40 mm. wide; abdomen 2.00 mm. long, 1.80 mm. wide.

Cephalothorax as long as wide, eyes four pairs, lateral eyes larger, posterior median eyes smaller than the anterior medians, except the



Text-fig. 2. *Synaema decorata* sp. nov.

(a) Dorsal view of whole body of female; (b) Dorsal view of whole body of male; (c) Male pedipalp.

posterior median eyes all ringed with chalk-white ocular tubercles, lateral tubercles contiguous; ocular quad slightly wider than long, space of anterior median eyes a little smaller than that of the posterior median. Clypeus narrow, margin of clypeus bearing slender spines. Legs I and II pairs longer than III and IV; tibia of I leg with four pairs of ventral spines, bases of spines black, the first pair of spines shortest.

Abdomen more or less elliptical, dorsoventrally flattened. Very slightly overlapping the cephalothorax, four pairs of circular black spots on the dorsum near the lateral margin, the posterior pair largest.

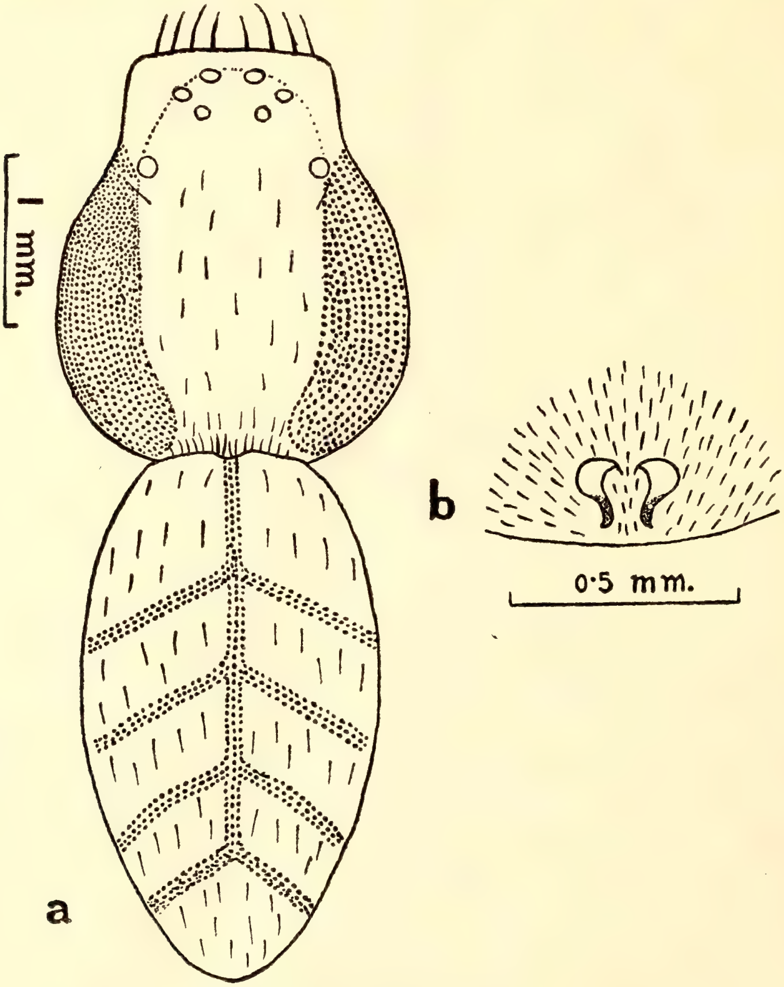
Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-4-1958

This species resembles *Synaema parvula* (Hentz), but is separated as follows: (i) Cephalothorax green but in *S. parvula* brownish yellow; (ii) Four pairs of circular black spots on the dorsum near the lateral margin, but in *S. parvula* no such black spots, only a broad transverse black or brown band near the hind end of abdomen.

Tibellus elongatus sp. nov. (Fig. 3)

General: Cephalothorax pale-greenish, eyes black, legs pale-green, Clypeus green, abdomen brownish. Total length 8.90 mm.; carapace 4.00 mm. long, 3.50 mm. wide; abdomen 5.00 mm. long, 2.80 mm. wide.



Text-fig. 3. *Tibellus elongatus* sp. nov.
(a) Dorsal view of whole body ; (b) Epigynum.

Cephalothorax longer than wide, sparsely spined, sides about ¼ portion with dark brown pigmented patches; clypeus medium, margin of clypeus with eight spines directed forward. Anterior row of eyes closer, recurved, anterior four eyes and posterior two median eyes form a wide hexagonal area, posterior lateral eyes remote from other eyes and the largest. Legs long, spined, bearing numerous black pigmented dots, I and II pairs of legs longer than the others, tibiae I and II with three pairs of ventral spines in the apical three-fourths.

Abdomen long, cylindrical, spined, narrower behind, very slightly overlapping the posterior region of cephalothorax, with a long median black pigmented line from nearly the base of abdomen to tip, four pairs of transverse pigmented lines from the median line to the lateral margin, these four pairs almost parallel with each other. Epigyne as in Fig. 3.

Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-6-1958.

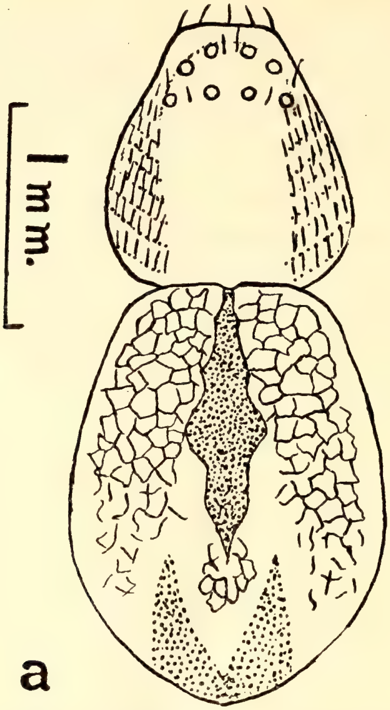
This species resembles *Tibellus duttoni* Keyserling, but is separated as follows: (i) Cephalothorax with two lateral dark brown pigmented patches, but in *T. duttoni* with three longitudinal brown stripes; (ii) Abdomen with a long median black pigmented line from base to tip and four pairs of transverse pigmented lines from the median line to the lateral margin, but in *T. duttoni* with three longitudinal brown stripes from base to tip of the abdomen.

Thanatus dhakuricus sp. nov. (Fig. 4)

General: Cephalothorax pale greenish, eyes black, legs green, clypeus concolorous with cephalothorax, abdomen green, with white patches. Total length 3.20 mm.; carapace 1.20 mm. long, 1.10 mm. wide; abdomen 2.00 mm. long, 1.50 mm. wide.

Cephalothorax broadest behind, narrowing in front, maximum width slightly less than length, covered with small hairs, the sides about ¼ portion tinted with very light yellowish and ornamented by irregular dark pigmented patches, this area clothed with many small spines. Eyes black, equal, eight in two rows both recurved but the posterior row longer; both the rows form together a crescent-shaped area. Clypeus long, margin of clypeus with four spines directed forward. Legs relatively short and stout, spined and with dark brown pigmented dots.

Abdomen oval, clothed with pubescence; with white, irregular shaped, granular patches; longitudinal brown lance-shaped band anteriorly in the mid-dorsal, two longitudinal deep brown bands on either side of the posterior end.



Text-fig. 4. *Thanatus dhakuricus* sp. nov.
(a) Dorsal view of whole body.

Holotype: One female in spirit.

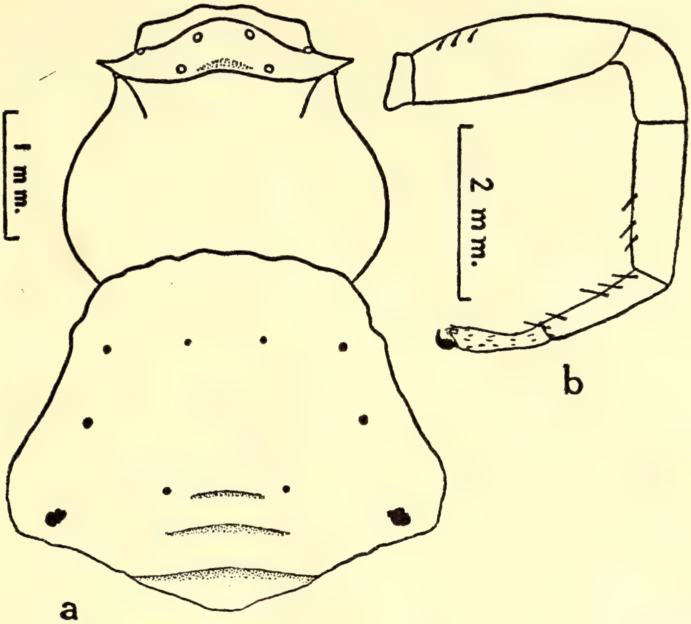
Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-5-1958.

This species resembles *Thanatus lycosoides* Emerton, but is separated as follows: (i) Cephalothorax pale greenish, but in *T. lycosoides* cephalothorax reddish-yellow with median longitudinal, brown band; (ii) Two longitudinal deep brown bands on either side of the posterior end of abdomen, but in *T. lycosoides* with an undulating brown band on each side of the hind part of abdomen; (iii) Eyes more or less equal in size, but in *T. lycosoides* the anterior median eyes much smaller than the anterior lateral eyes.

Thomisus bulani sp. nov. (Fig. 5)

General: Cephalothorax greenish, ocular area whitish triangular, with a transverse yellow patch between the posterior median eyes; eyes black, clypeus green, legs also greenish, abdomen white. Total length 5.00 mm.; carapace 2.50 mm. long, 2.30 mm. wide; abdomen 3.40 mm. long, 3.60 mm. wide.

Cephalothorax high, as long as wide. Anterior median and anterior lateral eyes more or less equal. Clypeus moderate, sub-rectangular. Legs long and stout, I and II legs longer than others. Metatarsi of I and II legs with five pairs of ventral spines, posterior legs without spines; I pair of legs with three spines on each femur in front but not arising from black pigmented spots.



Text-Fig. 5. *Thomisus bulani* sp. nov.

(a) Dorsal view of body; (b) 1st leg.

Abdomen pentagonal, overlapping the posterior region of cephalothorax in front, broadest just behind the middle, with three pairs of reddish-brown spots on dorsal surface near the lateral border; the spots arranged in longitudinal rows, the posterior pair of spots the largest; four very minute reddish-brown spots present on the middle and some times only two spots; posterior end with conspicuous transverse muscular corrugations.

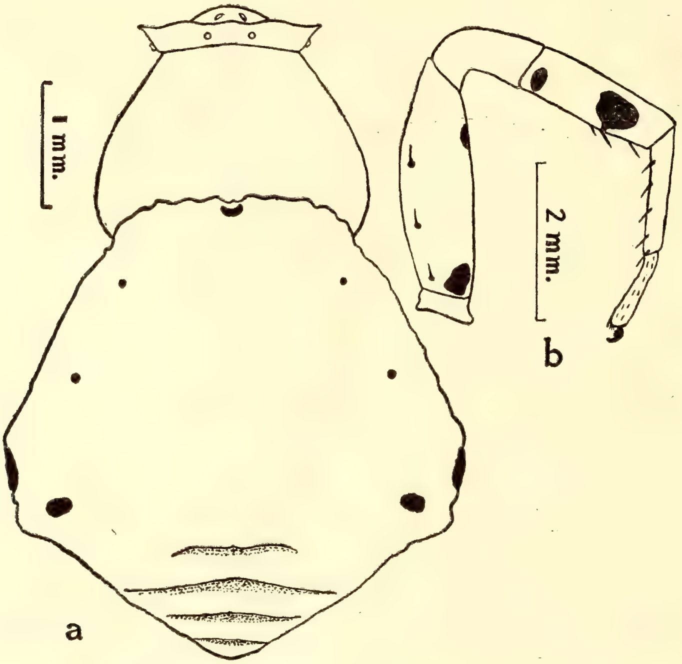
Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 14-3-1958.

This species resembles *T. pugilis* Stoliczka but is separated as follows: (i) Black spots on the dorsal side of abdomen, no such spots in *T. pugilis*; (ii) Clypeus green, but in *T. pugilis* clypeus whitish like ocular area; (iii) Three spines on the femur of 1st legs, but no such spines in *T. pugilis*.

Thomisus dhakuriensis sp. nov. (Fig. 6)

General: Cephalothorax brownish-green; ocular area yellowish-brown, with small chalk-white patches; eyes black; clypeus green, with dark brown in the middle; legs also greenish; abdomen chalk-white. Total length 5.50 mm.; carapace 2.50 mm. long, 3.00 mm. wide; abdomen 4.00 mm. long, 3.70 mm. wide.



Text-fig. 6. *Thomisus dhakuriensis* sp. nov.

(a) Dorsal view of whole body ; (b) 1st leg.

Cephalothorax broadest posteriorly slightly narrowing in front, maximum width slightly more than length. Eyes four pairs. Anterior median eyes somewhat smaller than the anterior laterals; clypeus long, subrectangular. Legs long and stout, I and II legs longer than III and IV legs; I leg with conspicuous black spots basally below on femur, a narrow black spot subapically on tibia in front; with three spines from black pigmented spots on each femur in front; II leg with a black spot basally below on femur and a narrow black spot basally in front on tibia, metatarsi of I and II legs with five pairs of ventral spines, III and IV pairs of legs unspotted and without spines.

Abdomen pentagonal, overlapping the posterior region of cephalothorax in front, broadest just behind the middle, with four elliptical black spots laterally, two on each side, one near the broadest region and the other near the anterior region. Three pairs of very dark brown spots sublaterally on dorsal surface, black spots arranged in longitudinal rows; posterior pair the largest; a single minute crescent-shaped black spot medially at anterior margin, posterior end with conspicuous transverse muscular corrugations.

Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 30-3-1958.

This species is very near *T. pugilis* Stoliczka, with the type of which it has been compared, but differs as below: (i) Cephalothorax smaller than in *T. pugilis*; (ii) Femora and tibiae of I and II legs with conspicuous black spots; no such spots in *T. pugilis*; (iii) Abdomen longer, dorsal and lateral sides bearing black spots; no such black spots in *T. pugilis*.

Thomisus projectus sp. nov. (Fig. 7)

General: Cephalothorax greenish; clypeus and abdomen chalky white. Total length 6.80 mm.; carapace 3.80 mm. long, 3.40 mm. wide; abdomen 4.00 mm. long, 4.10 mm. wide.

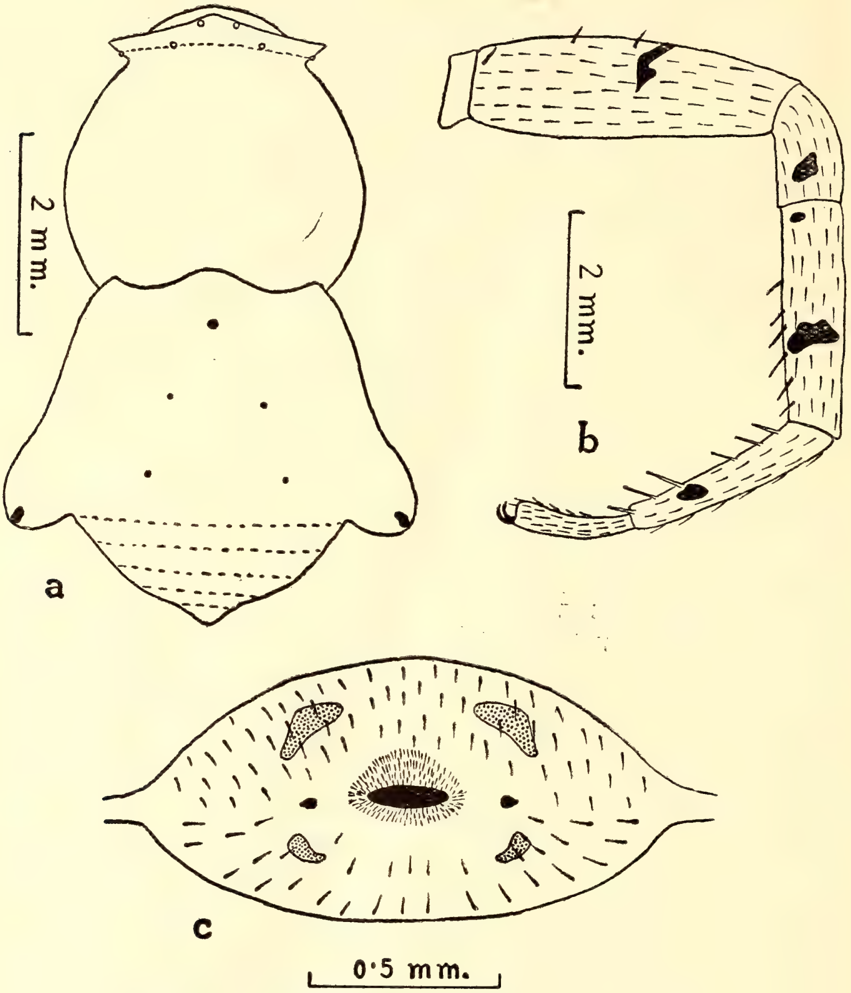
Cephalothorax pentagonal in shape, with a transverse yellow band on the ocular area; narrowing slightly in front, maximum width slightly less than length. Anterior median eyes slightly smaller than anterior laterals. Clypeus long, subrectangular. Legs long and stout, I and II longer than III and IV. I legs with a conspicuous incomplete transverse black mark anteriorly above on femur, a narrow black spot in front on patella, a small spot on the base, a large black spot subapically on tibia in front and a faint brown patch on the tip of metatarsus; I pair of legs with three spines above on femur; II legs with a small black spot on patella and a black spot subapically on tibia in front; metatarsi I and II with six pairs of ventral spines; III and IV pairs spotless and spineless.

Abdomen pentagonal slightly overlapping the posterior region of cephalothorax in front, broadest at the middle, this portion tuberculating laterally and a black spot on the top of tubercle, a yellow spot just inner side of black spot; posterior half of abdomen with prominent transverse muscular corrugation. Epigyne as in Fig. 7.

Holotype: One female in spirit.

Type-locality: Habra *c.* 48 kilometres north-east of Calcutta. Coll. B. K. Tikader, 7-9-1958.

This species is near to *T. pugilis* Stoliczka, with the type of which it has been compared, but differs as follows: (i) I legs with conspicuous black spots, no such spots in *T. pugilis*; (ii) Abdomen broadest at the middle, this portion tuberculating laterally and a black spot on the top and a yellow spot just inner side of black spot, but in



Text-fig. 7. *Thomisus projectus* sp. nov.

(a) Dorsal view of whole body ; (b) 1st leg ; (c) Epigynum.

T. pugilis abdomen broadest at behind the middle and no such spots and tubercle.

SUMMARY

Seven new species of spiders are described in this paper. All were collected from West Bengal, six of them from a suburb of Calcutta.

The new species belong to five genera distributed in the family Thomisidae.

ACKNOWLEDGEMENTS

I am thankful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for facilities for this work and to Dr. M. S. Mani, Deputy Director, for guidance, and for going through the manuscript and offering valuable suggestions.

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The Vegetation of Kanyakumari District (Cape Comorin)

BY

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(*With a map*)

SYNOPSIS

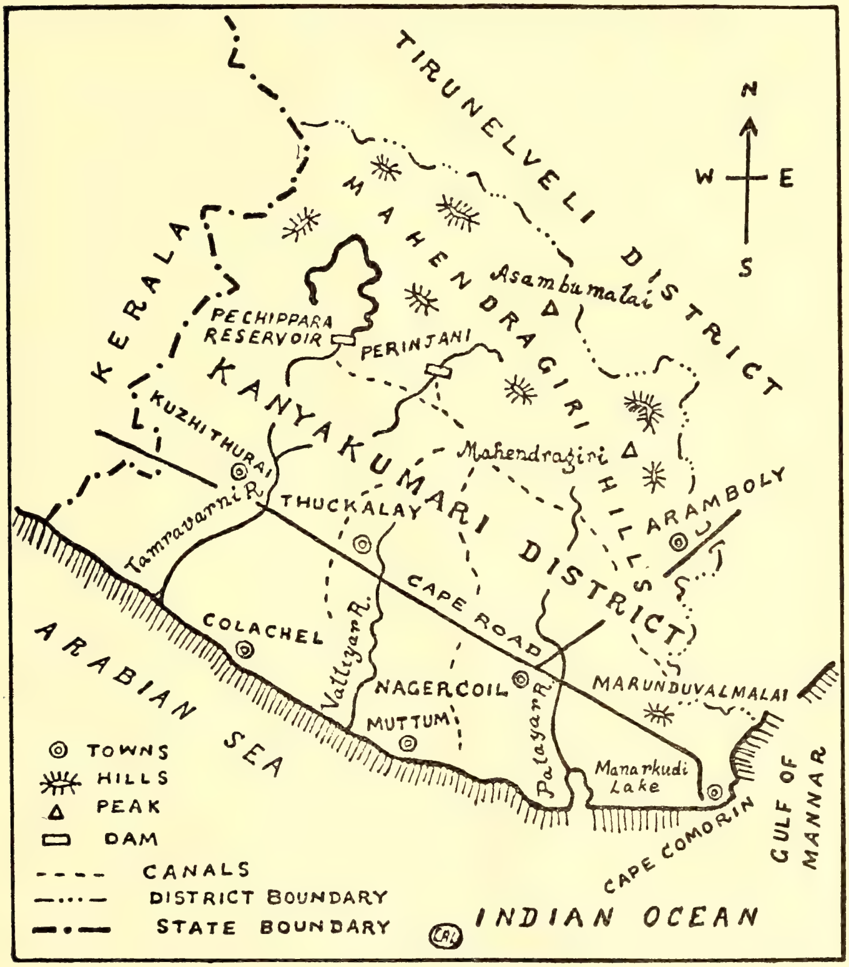
A floristic survey of Kanyakumari district has been made to discover the ecological status of the plant communities and their succession. The present paper shows that the interaction of various factors, mainly the climatic ones, have made Kanyakumari to acquire, on the north and northwest, the same type of succession and vegetation as are typical of the west coast and, on the south, the characteristic xerophilous vegetation of the eastern districts of Madras State especially Tirunelveli. The preponderance of a rich hydrophyte flora on the Nanjinad plain, which is fundamentally an arid zone, is probably due to the biotic factor.

INTRODUCTION

The vegetation of Kanyakumari district, which was a part of the erstwhile Travancore-Cochin State, is described in Rama Rao's FLOWERING PLANTS OF TRAVANCORE (1914) and in TRAVANCORE STATE MANUAL (1940). But these descriptions are very meagre and do not tell us about the ecology of the constituents. Therefore a floristic survey of Kanyakumari district from an ecological standpoint was made by the author in the period 1954-59.

SITUATION AND TOPOGRAPHY

Kanyakumari district, situated between latitude 8° 2′ and 8° 8′ N. and longitude 70° 1′ and 70° 7′ E., has a total area of 1365 square kilometres. It forms the southernmost district of Madras State and the southern termination of the Indian peninsula. This district comprises four taluks, Thovala, Agasteeswaram, Kalkulam, and Vilavamcode. On the north the Western Ghats form a natural boundary and the mountain passes at Aramboly and Yedamally facilitate communication with the rest of Madras State. On the northwest it is bounded by Kerala. Three sides of this district are washed by the sea—Gulf of Mannar on the southeast, the Indian Ocean on the south, and the Arabian Sea on the west.


TIRUNELVELI DISTRICT
KERALA
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MAHENDRAGIRI HILLS
Asambumalai
PECHIPPARA RESERVOIR
PERINJANI
KANYAKUMARI DISTRICT
KUZHITHURAI
Mahendragiri
Tamravarni R.
THUCKALAY
ARAMBOLY
CAPE ROAD
COLACHEL
Valliyar R.
NAGERCOIL
Palayar R.
MARUNDUVALMALAI
MUTTUM
ARABIAN SEA
Manarkudi Lake
CAPE COMORIN
GULF OF MANNAR
INDIAN OCEAN
◎ TOWNS
HILLS
△ PEAK
▭ DAM
- - - - CANALS
—...— DISTRICT BOUNDARY
—•— STATE BOUNDARY

Kanyakumari District

Topographically Kanyakumari district may be roughly divided into three natural regions:

(1) *The Coastal Region:* Kanyakumari has 68 kilometres of sea-coast. The soil is alluvial and very fertile. Many of the important townships and the Colachel port are located on this strip. There is

no bay or gulf on the western shore. The coast is rocky at Cape Comorin and Muttum. A chain of rocks locally known as Crocodile Rock projects a few furlongs into the sea at Muttum point. A lighthouse has been constructed here to give warning signals to passing ships. There is a sea cliff at Colachel. The havoc done by sea erosion is visible at several places along the coast. According to local Tamil legend, there was land beyond Cape Comorin with a hill named Kumaricode and a river known as Paruliyar. It is believed to have been swallowed by the sea thousands of years ago.

(2) *The Midland Region:* This is full of hills and dales that stretch slantingly from east to west, approximately 60 metres above sea-level. The soil of this area is gravel mixed with pebbles. The Trivandrum-Cape road runs along this strip touching Kuzhithurai, Thuckalay, and Nagercoil. The presence of a large number of perennial and ephemeral tanks and irrigation canals promotes a rich hydrophyte vegetation.

(3) *The Mountainous Region:* The Mahendragiri hill ranges extending as a continuation of the Western Ghats with two peaks, Asambu hill (1524 metres) and Mahendragiri peak (1707 metres), terminate on the south at Marunduvalmalai near Cape Comorin. In many places branches of the hill ranges thrust forward into the Midland Region east to west, enclosing fertile valleys. The rain-bearing monsoon winds cannot give maximum rainfall because of the low height of the Western Ghats towards the south. The sides of the hills are rugged and precipitous.

The Palayar, the southernmost river of the Indian peninsula, takes its source from Mahendragiri. While flowing through the Nanjinad plain the waters are diverted for irrigation all along its course of 37 kilometres until it falls into the Arabian Sea through Manarkudi lake, the only backwater in this district. Besides this river there are two others, the Valliyar and the Tamravarni. The Valliyar starts from the Velimalai hills and joins the Arabian Sea at Kadiapatnam estuary. It is practically dry in summer, but flooded during the monsoon season. Of all rivers only Tamravarni is wide and deep enough to be navigable for about 27 kilometres. The waters of this river have been stored by constructing two dams one at Pechippara and another at Perinjani and are diverted into irrigation canals, to be distributed among the paddy fields of Nanjinad. The Tamravarni empties itself into the Arabian Sea at Tengapatanam where it forms a small delta.

CLIMATE

Kanyakumari possesses a monsoon type of climate. The annual rainfall varies at different stations along the west coast, progressively increasing as we go from south to north, and ranges from about 89 cm. at Cape Comorin to 254 cm. at Pechippara. The Southwest Monsoon prevails over this district from June to September and the Northeast Monsoon brings rain in October and November. The total rainfall, though higher than that of Tirunelveli, is much lower than that of Kerala even though the rains last for about six months. The annual mean temperature is about 26° C. The cold season extends from December to February and in the beginning of this season a dry land breeze from Tirunelveli penetrates the Aramboly pass with great velocity and enters this district. The highest temperatures have been recorded in April. The temperature is lowest when the rainfall is maximum, in the month of October.

The wind velocity is high at Cape Comorin and at higher elevations. Even though the velocity is greater during the monsoon, cyclones are rare. A cyclone of mild strength was observed in June 1958. Minimum velocity is recorded in October during the reversal of the wind system. Summer storms occur in April and May accompanied by thunder showers. The hot wet climate favours a luxuriant vegetation.

VEGETATION

For convenience in study the district was taken up zone-wise:

1. The Mahendragiri Hill Ranges: The Mahendragiri hills are wholly forest-clad. The Southwest Monsoon being stronger than the Northeast Monsoon, the western face of the hill ranges gets more rain. This face is very steep and almost inaccessible and the vegetation is very luxuriant. But along the paths and at lower levels, the forests have been cleared. In these much-cut areas there has been lot of erosion and rocks have got exposed. In between these rocks grow trees with low gnarled trunks, smooth white bark, and coriaceous leaves, such as *Cinnamomum zeylanicum* Nees, *Hopea parviflora* Bedd., *Nyctanthes arbor-tristis* Linn., *Lagerstroemia lanceolata* Wall., *Eugenia jambolana* Lam., *Emblica officinalis* Gaertn., and many others. The rest of the hill ranges contain vigorously growing trees, at lower levels deciduous monsoon forest plants mixed with some xerophytes, and at higher levels, above 1000 metres, evergreen rain-forest species mixed with deciduous ones.

In the deciduous forest region, the trees are tall, straight, and close together, and the undergrowth is scanty. Huge lianes extend from tree to tree. Mistletoes and epiphytic orchids and ferns grow on the tree trunks. During the monsoon many bulbous and rhizomatous plants are very common on the forest floor. All along the montane region, up to an elevation of about 900 metres, *Bambusa arundinacea* Willd. and *Ochlandra travancorica* Gamb. are abundant.

The tops of hills and the rugged precipitous slopes are covered with deciduous trees especially *Bombax malabaricum* DC., *Tectona grandis* Linn. f., *Dalbergia latifolia* Roxb., *Schleichera trijuga* Willd., *Pterocarpus marsupium* Roxb., *Terminalia crenulata* Roth., *Hiptage madablota* Gaertn., and *Ficus glomerata* Roxb. The shrubs forming the undergrowth are *Ixora coccinea* L., *Streblus asper* Lour., *Alangium salvifolium* (Linn. f.) Wang., *Strychnos nuxvomica* Linn., *Helicteres isora* Linn., *Hibiscus micranthus* (Linn. f.), *Calycopteris floribunda* Lamk., and *Mussaenda frondosa* L. *Ichnocarpus frutescens* R. Br., *Abrus precatorius* Linn., *Smilax macrophylla* Roxb., *Cissampelos pareira* Linn., *Gloriosa superba* L., *Zizyphus oenoplia* Mill., and *Lantana camara* L. var. *aculeata* L. are the chief climbers and scramblers. The annually cleared areas near the dak bungalows and along the paths are occupied by tall grasses, e.g. *Heteropogon contortus* Roem., *Pennisetum polystachyon* Schltz., *Sehima nervosum* Stapf., and *Cynodon dactylon* Pers. Among these grow *Anisomeles malabarica* (Linn.) O. Ktz., *Pseudarthria viscida* W. & A., *Tragia involucrata* Linn., and other erect annual dicots. Several species of crustose, foliose, and fruticose lichens, and mosses occur as epiphytes and lithophytes. *Selaginella rupestris* (L.) Spreng., *Lycopodium* spp., *Adiantum caudatum* Linn., *Cheilanthes mysorensis* Wall., *Actinopteris dichotoma* Forsk., *Lygodium flexuosum* Sw., *Nephrolepis* spp., and many other plants grow under the shade of trees and near the springs, ponds, and streams. A large number of shrubs grow as chasmophytes in the crevices of rocks filled with debris, such as *Pavetta indica* Linn., *Indigofera enneaphylla* Linn., *Holarrhena antidysentrica* (Linn.) Wall., *Triumfetta rhomboidea* Jacq., *Bryophyllum pinnatum* Kurz., and *Sansevieria zeylanica* Willd., mixed with *Cymbopogon flexuosus* (Nees) Wats., and *Phoenix humilis* Royle. The herbs are *Desmodium pulchellum* (Linn.) Benth., *Polygala chinensis* Linn., *Blumea wightiana* DC., *Aerva lanata* (Linn.) Juss., *Waltheria indica* Linn., and some grasses. There are also scramblers such as *Calamus rotang* L., *Combretum decandrum* Roxb., and *Entada scandens* Benth. At higher elevations cashew and rubber plantations have been established in several places especially at the Balamore, Vaikundam, and Palazhi estates.

Just a small bit of land is kept under cultivation by the hill tribe, Kanikkars.

2. The Rivers and Canals: In the Anandan Canal Thovala Channel and Puthanar Channel and its branches the water is always turbid; as a consequence thereof very few plants can grow. The same is the case with rivers during the monsoon. But in summer there is very little water in Valliyar and Palayar so that pools and puddles are formed here and there. Such spots harbour masses of *Spirogyra*, and *Oscillatoria*. In shallow water, there also grow *Eichornia crassipes* Solms., *Pistia stratioides* Linn., and *Vallisneria spiralis* Linn. Sometimes masses of these are uprooted and are carried to sheltered spots, where the growth continues.

3. The Banks of the rivers Tamravarni, Valliyar, and Palayar: The banks of these rivers are comparatively low and in several places bunds have been constructed to prevent breaches during the monsoon floods. Along the bunds grow several plants such as *Pandanus odoratissimus* Roxb., *Saccharum arundinaceum* Retz., *Melastoma malabathricum* L., and sandbinding sedges such as *Cyperus arenarius* Retz., *Fimbristylis meliacea* Vahl., and *Bulbostylis barbata* Kunth.

During the monsoon these banks are partially submerged, but they are exposed by the middle of November when the flood water starts receding. They remain damp for several months thereafter. Soon-after the water has receded, *Justicia procumbens* Linn., *Lippia nodiflora* Mich., *Polygonum plebejum* R. Br., *Eclipta alba* Hassk., *Elephantopus scaber* L., *Commelina benghalensis* L., various sedges, and other amphibious and wet meadow plants begin growing. By early summer these plants are dead and are replaced by dry meadow plants like *Argemone mexicana* L., *Ionidium suffruticosum* Ging., *Asteracantha longifolia* Nees., *Clerodendron inerme* Gaertn., and *Croton sparsiflorus* Morr.

On the silty banks of Tamravarni River, several trees flourish such as *Holigarna arnottiana* Hk. f., *Spondias mangifera* Willd., *Barringtonia racemosa* Roxb., *Sterculia foetida* L., and *Alstonia scholaris* R. Br., and they support many lianes, parasites, and epiphytes.

4. The Low-lying Lands: The annually inundated low lands of Vilavancode and Kalkulam show a rich amphibious vegetation during the rains consisting of various sedges and grasses like *Ageratum conyzoides* L., *Fimbristylis miliacea* Vahl., *Panicum repens* Linn., and

Aneilema nudiflorum R. Br. In summer most of the land is kept fallow when amphibious annuals perish followed by a succession of dry meadow plants, such as *Sphaeranthus indicus* L., *Scoparia dulcis* L., *Euphorbia hirta* Linn., *Phyllanthus niruri* Linn., and *Merremia emarginata* (Burm. f.) Hall. The small ditches along the roads hold water during the rainy season and show *Spirogyra, Nostoc,* and other algae, followed by ricefield flora later. Grasses such as *Cynodon dactylon* (Linn.) Pers., *Eragrostis coarctata* Stapf., *Iseilema laxum* Hack., and *Cenchrus setigerus* Vahl. are seen in early summer on the sides of these ditches.

5. The Ruins of the Houses, Dust Heaps, and Building Sites at Kuzhithurai and Thuckalay: The ruins of houses show a luxuriant growth of *Chloris montana* Roxb., *Trianthema portulacastrum* L., *Portulaca oleracea* Linn., *Tridax procumbens* Linn. and *Datura stramonium* Linn. On the dilapidated walls of the *mandapams* constructed long ago for the use of travellers along the Cape Road grow *Lantana camara* Linn., *Ficus benghalensis* Linn., *Stachytarpheta indica* Vahl., *Pilea microphylla* Liebm., and *Barleria prionitis* L., and occasionally *Lochnera rosea* Reichb. and *Jasminum pubescens* Willd.

The dust heaps and garbage dumps show a variety and luxuriance which is unique. Most of the common weeds of the district are found here, particularly *Amaranthus spinosus* Linn., *Cleome viscosa* Linn., *Gynandropsis gynandra* (Linn.) Briq., *Argemone mexicana* Linn., *Achyranthes aspera* Linn., *Anisomeles ovata* R. Br. and *Euphorbia heterophylla* L. Mixed with these weeds occur stray plants of household use such as *Brassica nigra* Koch., *Cucumis sativus* L., *Coriandrum sativum* L., and *Capsicum frutescens* L., that reach there along with sweepage. Ultimately *Croton sparsiflorus* Morr. dominates.

6. The *Purambokku* Fallow Lands along the Roads and Canals: These are dry meadows covered with fodder grasses such as *Vetiveria zizanioides* Nash., *Eleusine aegyptiaca* Desf., *Cenchrus ciliaris* Linn., and *Chloris barbata* Sw. Soon after the rains many other plants appear among these, such as *Ocimum basilicum* L., *Crotalaria prostrata* Roxb., *Desmodium trifolium* DC., *Ruellia tuberosa* L., *Tephrosia purpurea* Pers., *Cassia siamea* Lam., and *Cassia occidentalis* Linn. Soon invasions of *Eupatorium heterophyllum* DC. take place in such localities. In areas which are protected from grazing there grow many perennial grasses such as *Heteropogon contortus* Beauv., *Chrysopogon montanus* Trin., and

Panicum prostratum Lamk., along with many others listed above. Among these grow *Physalis minima* L., *Leucas aspera* Linn., *Acanthospermum hispidum* DC., and other erect annual dicot herbs, giving a characteristic grassland population. A longer period of protection results in the formation of a scrub jungle consisting of species like *Zizyphus jujuba* Lamk., *Morinda tinctoria* Roxb., *Pithecolobium dulce* (Roxb.) Benth., and *Jatropha gossypifolia* Linn. Climbers like *Cardiospermum halicacabum* L., *Melothria maderaspatana* (Linn.) Cogn., *Clitoria terneata* L., and *Pergularia doemia* (Forsk.) Blatt. grow on these trees during the rains and early summer. The hedges of this area are composed of plants such as *Euphorbia antiquorum* Linn., *Euphorbia nivulia* B.-Ham., *Jatropha curcas* Linn., *Erythrina indica* Lam., *Moringa oleifera* Lamk., *Plumeria acutifolia* Poir., *Thevetia neriifolia* Juss., and *Adhatoda vasica* Nees, which are propagated vegetatively during the monsoon season.

7. Nagercoil town, the Mango Orchards, and the Maidans: The building sites in Nagercoil present a different flora. There are many plants of the scrub jungle, such as *Gmelina arborea* Roxb., *Aegle marmelos* Correa, *Feronia elephantum* Correa, *Canthium angustifolium* Roxb., and *Cassia auriculata* Linn., mixed with herbs such as *Sida carpinifolia* L. f., *Polycarpea corymbosa* Lamk., *Zornia diphylla* Pers., *Mimosa pudica* L., *Alysicarpus monilifer* DC., and climbers like *Tylophora asthmatica* W. & A., *Asystasia coromandeliana* Nees, and *Coccinia indica* Wt. & Arn.

Due to severe soil erosion deep gulleys have been formed in many parts of the town. Vegetation here is very sparse with only a few drought resistant succulents such as *Cissus quadrangularis* Linn. and *Opuntia dillenii* Haw., dotted here and there. But during the monsoon, these are filled with water and then appear plants such as *Borreria hispida* (Linn.) Schum., *Aerva tomentosa* Forsk., *Digera alternifolia* Aschers., and *Mollugo cerviana* Ser. On the banks of the gulleys are seen shrubs like *Anona squamosa* Linn., *Bauhinia purpurea* L., *Vitex negundo* Linn., *Calotropis gigantea* Ait., and *Psidium guajava* L.

The orchards show a mixed vegetation generally comprising *Mangifera indica* L., *Anacardium occidentale* L., and *Calophyllum inophyllum* L. intermingled with trees which supply green manure such as *Thespesia populnea* Corr., *Cassia fistula* L., *Azadirachta indica* A. Juss., and *Poinciana elata* L. Sometimes *Tamarindus indica* Linn., *Ficus benghalensis* L., and *Borassus flabellifer* L. grow among them. The weeds growing sheltered under these trees consist chiefly of *Barleria noctiflora* Linn., *Acalypha indica* (Linn.) Bedd., *Tribulus terrestris* Linn., and *Gomphrena decumbens* Jacq.

The Municipal Maidan, S.L.B. Maidan, and other open grounds in and around Nagercoil seem to be completely denuded and barren, with stray plants of *Aristida adscensionis* Linn., *Boerhavia diffusa* Linn., *Cassia auriculata* Linn., and *Calotropis gigantea* Ait. exhibiting remarkable capacity for drought resistance.

8. Plants on the bunds of Nanjinad Paddy Fields: There are sand-binders such as *Cyperus arenarius* Retz., *Kyllingia cylindrica* Nees., *Panicum crus-galli* L., *Paspalum scrobiculatum* Linn., and others which persist as perennials. But during the irrigated periods and the rains many weeds grow on the bunds, like *Centella asiatica* (Linn.) Urban, *Monochoria vaginalis* Presl., *Marsilea quadrifolia* L., *Biophytum sensitivum* DC., and *Saccharum spontaneum* L., with clumps of *Pandanus odoratissimus* Roxb. here and there. On bigger bunds grow *Cocos nucifera* Linn., *Sesbania grandiflora* Pers., and some annuals such as *Phaseolus trilobatus* Ait., *Heliotropium indicum* L., *Eriocaulon sieboldianum* Seib. & Zucc., and *Ilysanthes serratus* Urb. Most of these annuals perish in summer.

9. Vattakottai, Mudforts, and Cape Comorin: This is a dry zone showing arid vegetation with the isolated Marunduvalmalai hill rising above the plains. Vegetation on this hill represents a typical scrub jungle (Lawrence, 1959). The gigantic hedge of xerophytes stretching from Vattakottai to Anjugramam comprises plants such as *Acacia aribica* Willd., and *Acacia planifrons* W. & A. as co-dominants, associated with *Dodonaea viscosa* L., *Phoenix humilis* Royle., *Casuarina equisetifolia* Linn., *Aloe vera* L., *Agave americana* L., *Alangium salvifolium* Wang., *Flacourtia sepiaria* Roxb., and *Euphorbia antiquorum* Linn., and climbers like *Asparagus racemosus* Willd., *Cocculus hirsutus* (Linn.) Diels., and *Coccinia indica* Wt. & Arn. The scramblers are *Capparis aphylla* Roxb., *Todalia asiatica* Lamk., and *Acacia intsia* Lamk.

Inside the dilapidated mudforts of the late Rama Varma Maharaja flourish many plants like *Parkinsonia aculeata* L., *Carissa congesta* Wight, *Clerodendron infortunatum* Gaertn., *Evolvulus alsinoides* Linn., and *Nerium odorum* Soland.

At Cape Comorin *Acacia arabica* Willd. forms pure consociations on several acres of sandy soil.

10. Reservoirs and Irrigation Tanks: True aquatics such as *Nymphaea stellata* Willd., *Nelumbium speciosum* Willd., *Limnanthemum indicum* (Linn.) Griseb., *Jussiaea repens* L., *Ottelia alismoides* (Linn.) Per., *Neptunia oleracea* Lour., and *Ipomoea*

aquatica Forsk. occur in most of the irrigated tanks. Kallarkulam, Samanjankulam, and Putherikulam tanks show a luxuriant growth of *Trapa bispinosa* Roxb. as dominant, and in reservoirs with rich humus content *Eichhornia crassipes* Solms. abounds, choking the other aquatic vegetation. Free floating forms such as *Hydrilla verticillata* Presl., *Azolla pinnata* R. Br., *Pistia stratioites* Linn., and *Chara* spp. are very abundant in the huge reservoirs Vetkaikulam, Sundaikulam, and Parakkaikulam, mixed with the other hydrophytes mentioned above.

Halophytes of this area include such plants as *Alternanthera sessilis* (Linn.) R. Br., *Limnophila heterophylla* Benth., *Centella asiatica* (Linn.) Urban, *Aeschynomene aspera* L., *Polygonum glabrum* Willd., and *Cyperus* spp. During the unirrigated periods and in summer these are succeeded by dry meadow plants such as *Asteracantha longifolia* (Linn.) Nees, *Biophytum sensitivum* (Linn.) DC., *Eclipta alba* Hassk., and *Ludwiggia parviflora* Roxb.

Insectivorous plants such as *Drosera burmannii* Vahl., *Drosera indica* L., and *Utricularia* spp. are very common on the brink of water in Anandankulam tank near the Nagercoil T.B. Sanatorium, but are submerged during the monsoon, when the water level rises.

11. Plants on the Sea Coast: Between land and sea there is about 150 metres of shore. This strip shows sand dune vegetation. On the windward side of embryonic and adult sand dunes grow *Spinifex squarrosus* L. and *Ipomoea pes-caprae* Roth. as co-dominants. Also dotted on the sea-shore are deep-rooted herbs like *Launea pinnatifida* Cass., *Hydrophyllax maritima* L., *Scaeveola koenigii* Vahl, and sand-binding grasses.

The Kanyakumari sea-coast does not afford facilities for the development of mangrove flora.

The rocks on the waterfront at Muttum and Cape Comorin sea-shore harbour various marine algae such as *Sargassum, Ulva, Enteromorpha, Gracillaria, Dictyota, Corallina,* and *Chorenemorpha*, which are submerged during high tide.

12. Cultivated Lands: About 75 per cent of land in this district is under cultivation. In the *nanjai* fields of Nanjinad, paddy is cultivated twice a year, one crop being harvested in September and the other in February. During summer, vegetables such as *Abelmoschus esculentus* L., *Solanum xanthocarpum* Schrad. & Wendl., *Solanum melongena* L., *Trichosanthes anguina* L., *Momordica charantia* L., *Cucurbita maxima* Duch., and *Cucumis sativus* Linn. are grown in some paddy fields and irrigated by constructing temporary wells close by. Near the rivers and canals, plants such as *Musa paradisiaca* L.,

Piper betel L., *Colocasia antiquorum* Schott, *Amorphophallus campanulatus* Bl., and *Maranta arundinacea* L. are grown. At higher elevations and on hill slopes *Manihot utilissima* Pohl. is cultivated, and in some areas it is replaced by other tuber crops like *Dioscorea alata* L. and *Ipomoea batatas* Lam. Many drought-resistant weeds grow in such localities, e.g. *Blainvillea latifolia* DC., *Sida humilis* Willd., *Abutilon indicum* Sweet, *Oldenlandia paniculata* L., *Mollugo oppositifolia* Linn., and *Curculigo orchioides* Gaertn., mixed with *Lochnera pusilla* K. Schum., *Aerva lanata* Juss., and *Vernonia cinerea* Less., which spring up suddenly during the rainy season.

Near the villages and in house compounds are present mesophytes such as *Artocarpus integrifolia* L., *Artocarpus incisa* L., *Punica granatum* L., *Terminalia catappa* L., and also *Averrhoa carambola* L., *Citrus medica* L., *Achras sapota* L., *Lawsonia enermis* L., and *Murraya koenigii* Spreng. Coconut and Palmyra palms form a prominent part of the landscape all over the district.

CONCLUSION

The vegetation of Kanyakumari district stands in sharp contrast to the other areas of Madras State. The northern half of the district is characterised by different rock formations, so that the number of species is definitely higher. The herbaceous vegetation is also richer. The abundance of the flora is due to greater precipitation and humidity. On the other hand, the southern part is primarily an arid zone of sandy soil with trees having several xerophytic adaptations. Umbrella top is exhibited by *Acacia arabica* Willd. Reduction of leaf surface in *Casuarina equisetifolia* Forst., *Euphorbia tirucalli* L., and *Capparis aphylla* Roth., and succulent habit of *Aloe vera* L., *Sansevieria zeylanica* Willd., and *Euphorbia antiquorum* Linn. serve as very effective measures for drought resistance. The physical geography of this district presents variations that are vividly reflected on its flora, so that two small ecological areas could be recognised, a region of high rainfall on the north with luxuriant vegetation, and one of low rainfall with scanty vegetation on the south, the tropophytic type and the xerophytic type of vegetation respectively.

ACKNOWLEDGEMENTS

The author is deeply indebted to Dr. T. C. N. Singh, D.SC., F.B.S., Professor and Head of the Department of Botany, Annamalai University, for his valuable guidance and constant encouragement. He is grateful to the Systematic Botanist and Professor of Botany, Agricultural College and Research Institute, Coimbatore, for the identification of a number of specimens. The author also wishes to express his thanks to the Principal, Scott Christian College, Nagercoil, for various facilities provided, and to Dr. A. Abraham, M.A., M.SC., PH.D., Head of the Department of Botany, University College, Trivandrum, for his keen interest in this work.

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Some Observations on the Biology of *Labidura riparia* (Pallas) (Labiduridae, Dermaptera) from Poona

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(*With two text-figures*)

ABSTRACT

The earwigs were collected under mercury-vapour lamps on a riverside road (Fig. 1). They were reared in wooden cages as well as in

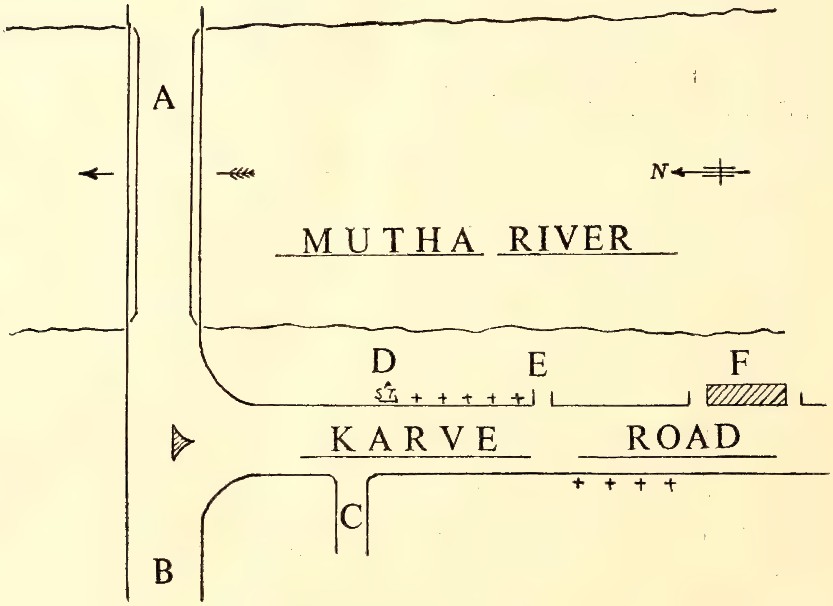

FIG. 1. Place of Collection

A. Sambhaji Bridge; B. Ferguson College Road; C. Prabhat Road; D. State Transport Bus Stop; E. Karve Road Market; F. M. E. S. College; +. Mercury Vapour Lamp.

glass jars to study their habits in nest building, feeding, mating, oviposition, maternal care, etc.

Various interesting observations are recorded and discussed.

INTRODUCTION

Little work seems to have been done on Dermaptera in India. De Bormans (1888) gave an account of a collection made by Leonardo Fea in Burma. Boliver (1897) described an extensive collection of Orthoptera from Trichinopoly in which several species of earwigs were recorded. Burr (1905, 1906, 1907) described some specimens from the Indian Museum.

Ramamurthy (1955) studied wing venation of *L. riparia* (Pall.) and *Forficula quadrispinosa* (Dohrn). Behura (1950) worked on the life-history of *Forficula auricularia* and wrote a note on the earwig as food of the little owl, *Athene noctua vidalii* Brehm, in Great Britain. Cherian and Basheer (1950) found *Eubrellia stali* (family Forficulidae) to be a pest of stored groundnuts.

An attempt was made to study the biology of earwigs under captivity in Poona. Similar studies have been made by Pesotskaia (1927). Weidner (1940), Schlinger *et al.* (1959) in other countries.

PLACE OF COLLECTION

The collection was made at Poona on a riverside road in a heavily populated area. In the immediate vicinity of the river it is, however, mostly open, and even in the residential areas there is plenty of vegetation, consisting mainly of: (1) *Acacia arabica* Willd., (2) *Ricinus communis* L., (3) *Lantana camara* L., (4) *Musa paradisiaca* L., (5) *Clerodendron siphonanthus* R. Br.

The collection was made under nine mercury-vapour lamps. Each lamp is of 125 watts at a mean distance of 46 metres (150 ft.).

METHOD OF COLLECTION

The earwigs were collected between 6.45 p.m. and 10.45 p.m. They were mostly found resting on the cement bases of the lamps. The specimens were collected by hand picking during November-December 1958 and in June 1959. Large numbers of specimens were obtained when the atmosphere was warm and humid. Earwigs were however scarce after heavy showers and/or when the atmosphere was comparatively cooler.

While collecting the earwigs the following important observations were made:

1. The earwigs were always resting quietly at the base of the lamp pole on its cement support.
2. When disturbed, they tried to run away but never took to wing.
3. It was observed that instead of going towards the light source they remained at the base. The distance between the light source and the base was about 6 metres (20 ft.).
4. In addition to *L. riparia* (Pall.) a few specimens of *L. bengalensis* (Dohrn) were collected.

METHOD OF REARING

Specimens were reared in wooden cages, with wiremesh and having moist soil at the bottom. Some specimens were isolated in glass jars, containing moist soil at the bottom. This was done to observe their nest building habits.

NEST BUILDING

Soon after confinement, the earwigs moved about in captivity and set to work nest building. They worked hour after hour, without caring either for their food or for their mate. The nest was nothing but a gallery, carved in the moist soil. The general shape of the gallery is tubular, (Fig. 2 A & B) but sometimes it varies in its pattern. In a few cases the main galleries have lateral branches (Fig. 2 C). Measurements of excavated galleries (Table I) were taken from actual casts of galleries prepared by pouring freshly prepared paste of plaster of Paris into them.

TABLE 1

MEASUREMENTS OF GALLERIES (AVERAGE OF SIX OBSERVATIONS)

Height of soil column.	Length of gallery before bend	Length of gallery after bend	Breadth of gallery	Angle at entrance	Angle at bend
2.6 cm.	2.0 cm.	1.2 cm.	0.7 cm.	37°	131°

The earwigs mainly employed their mouthparts for nest building. While digging the nest, the earwig frequently backed out of the gallery

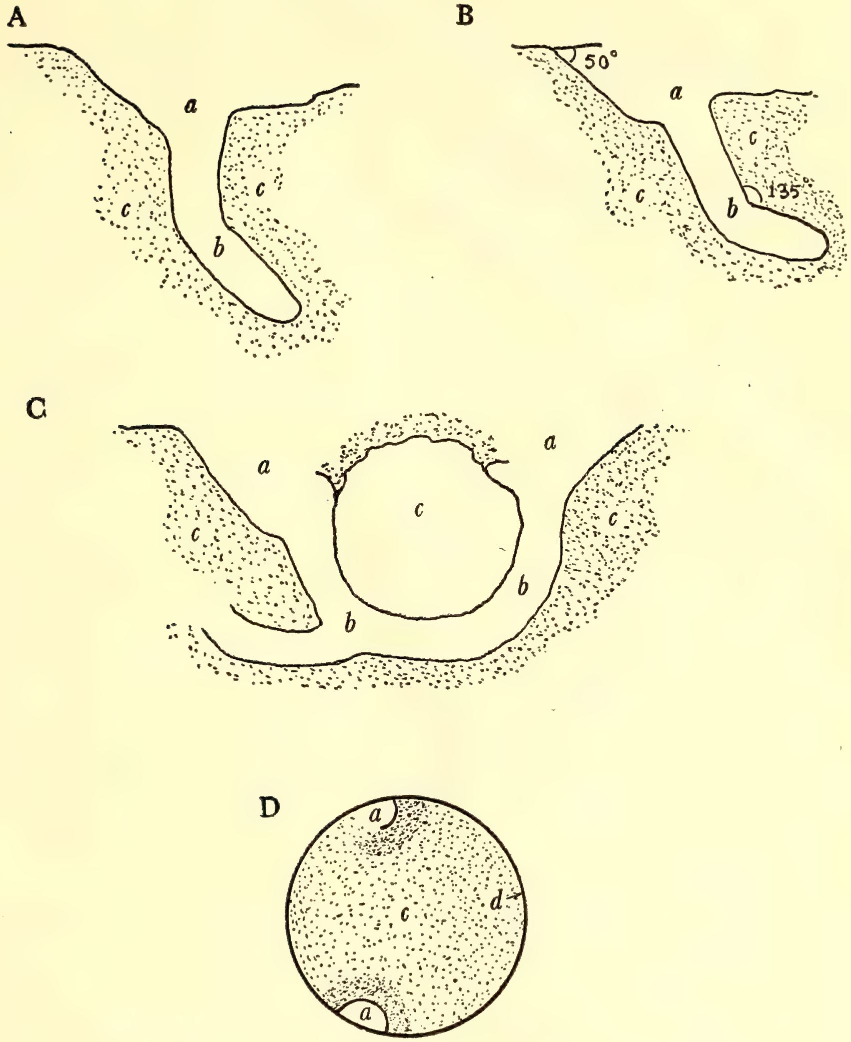

FIG. 2. Nests of Earwig

A, B, C. Longitudinal sections. D. Surface view. *a.* Opening of gallery; *b.* Lodging of earwig; *c.* Soil particles; *d.* Side of glass jar.

pushing the excavated soil particles against the sides of glass jars or to one side of the opening. In some cases it was observed that the earwig pressed the wet soil particles against the side of the glass jar so as to cover it as completely as possible. Fore-legs were also used during this process.

1. The attempt at nest building was only successful when the soil was moist. In dry soil the earwigs failed to build the nest. After such failures they took shelter under green or dry leaves, or spent a considerable time resting on the surface of the soil without any work. Moisture in the soil seemed absolutely necessary for their life; without it they became inactive and died.
2. Each and every individual, irrespective of sex, tried to build its own nest. They never helped each other in doing so.
3. It was observed that a few earwigs tried to build their nests at the sides of glass jars. (Fig. 2 D.)

FEEDING HABITS

In captivity, the earwigs were supplied with vegetable and animal food but the latter was preferred. The food accepted or rejected is summarised in Table II.

They were strongly attracted to soft bodied insects like nymphs of cockroach, houseflies, and some arachnids such as spiders.

When living insects were supplied the earwigs seized them by means of their strong forceps. On approaching the prey, the abdomen was twisted with a quick movement and forceps were shot out to grab it. The prey was eaten up from below or from the side. Soft specimens were completely devoured but in case of hard insects the terga, the sterna, the wings, and the legs were left behind.

When food supply was insufficient or if food was not supplied at all, cannibalism was frequent. Even newly emerged nymphs were eaten up by their mothers under similar circumstances.

COPULATION

Copulation in captivity took place at night at about 8-30 p.m. in three cases and in one case soon after midday. In coitus the pair remain tail to tail. The abdomen was twisted laterally, with left side turned upwards. The forceps of the male face the left side of female, which remains in her natural position. At the end of coitus the torsion of the abdomen of male was gradually reduced.

The act of copulation lasts about 2½ hours.

OVIPOSITION

The eggs were generally laid in the morning, at the bottom of the gallery. When the nest is destroyed the eggs are laid on the surface of the soil. At times the eggs are laid on the surface, the female briskly moving from one place to another depositing the eggs in groups at various places. Afterwards, all the eggs are collected at one place into a heap.

TABLE II

FOOD OF EARWIGS

Vegetable Food			Animal Food		
Type of food offered	Accepted food	Rejected food	Type of food offered	Accepted food	Rejected food
Coriander (leaves and stems)	..	Coriander (leaves and stems)	Moths (*Euproctis lunata*)	Moths (*Euproctis lunata*)	..
Tomato (fruit) pieces	..	Tomato (fruit) pieces	Small cockroaches (whole)	Small cockroaches (whole)	..
Knolkohl (leaves)	..	Knolkohl (leaves)	Earwigs (whole)	Earwigs (whole)	..
Bread	..	Bread	Houseflies (whole)	Houseflies (whole)	..
..	..	..	Spiders (whole)	Spiders (whole)	..
..	..	..	Small grasshoppers (whole)	Small grasshoppers (whole)	..
..	..	..			
..	..	..	Field crickets (whole)	Field crickets (whole)	..
..	..	..	Pentatomid bugs (whole)	..	Pentatomid bugs (whole)
..	..	..	Earth-worm pieces	..	Earth-worm pieces
..	..	..	Snail pieces	..	Snail pieces

The number of eggs laid varied; on the average each female laid 47 eggs. The above observations are summarised in Table III.

MATERNAL CARE

Both the eggs and the nymphs are carefully guarded by the mother. At intervals the female takes the eggs in her mouth one after the other and licks them clean. This keeps the eggs clean and shiny.

It was observed that if the eggs are displaced and kept at different places, the female again carries the eggs to one place and forms a heap. When the eggs are not guarded by the female they cling together, shrivel up, and perish. When the eggs were disturbed more than once, they were neglected and in some cases devoured by the female.

TABLE III

NUMBER OF EGGS LAID BY ONE FEMALE COLLECTED ON 23-11-1958

Date of egg laying	Days between two successive egg laying periods	Number of eggs laid	Date of emergence of nymphs	Incubation period of egg
3.12.1958	..	45	..	..
14.12.1958	11	50	22.12.1958	8
1. 1.1959	18	45	11. 1.1959	10
21. 1.1959	20	50	31. 1.1959	10
3. 3.1959	13	1	..	..
26. 3.1959	23	1	..	..

After emergence, the nymphs in the beginning were always with their mother, but after two to three days they begin to wander here and there, within close range of the mother. When they were disturbed they ran to their mother and tried to hide underneath her body. If the female noticed that the danger was beyond her capacity she tried to take shelter in her nest with her young ones.

Another interesting thing about her vigilance was observed. While watching her through glass jars it was noticed that the female was trying to close up a gap through which one could see the eggs that had been laid by her in the gallery. In a short time she filled up the gap with the moist soil.

DISCUSSION

As stated above, Pesotskaia (1927), Weidner (1940), Schlinger *et al.* (1959) have studied the biology of *Labidura riparia* (Pall.). The present observations are in conformity with the observations of the above authors in respect of feeding habits, mating, oviposition, etc., except in certain respects mentioned below;

Pesotskaia (1927) states that the female takes each egg in her mouth parts and covers it completely with liquid from glands, which protects the egg from mould. I did not observe such a secretion. If the eggs are not licked by the female or if they are neglected they shrivel and disintegrate, showing thereby that the attendance of female is necessary.

Attempts were made to determine whether the galleries are made at a fixed angle to the soil as stated by Pesotskaia (1927) and Weidner (1940). It was found that this species of earwig constructs the galleries at an angle to the surface which may vary between 44° to 55°. A similar investigation was made with regard to the angle at the bent. According to Pesotskaia it is between 115° to 130°. Present studies have shown that it is between 125° to 136° or even more.

ACKNOWLEDGEMENTS

Thanks are due to Prof. P. R. Damle, Principal, Nowrosjee Wadia College, and Prof. S. G. Nadkarni, Zoology Department, Nowrosjee Wadia College, for encouragement and facilities, and to Shri D. R. Ranade, Lecturer in Zoology and Entomology, Poona University, for his valuable guidance, and for going through the manuscript.

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Leaves and Tendrils as aids for Identification of Cucurbits

BY

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(*With six plates*)

INTRODUCTION

Usually plants are identified with the aid of floral characters. Some attempts have been made to identify the cucurbits by the anatomical characters of the stem (Ghosh, 1932) and of the petioles and midribs (Yasuda, 1901, 1903 ; Chakrabarty, 1937). But the present author is not aware of any attempt to identify the cucurbits with the aid of the morphological characters of the leaves and tendrils though they exhibit some interesting features with conspicuous differences ; this attempt has been made from that point of view.

MATERIALS AND METHODS

Materials of the following twenty-four species were collected from different parts of Bengal and herbarium sheets were prepared in the usual way :

SPECIES	VERNACULAR NAME	HABITAT
1. *Benincasa hispida* Cogn.	Chalkumra	Cultivated & wild
2. *Bryonopsis laciniosa* Naud.	Mala	Wild
3. *Citrullus colocynthis* (Linn.) Schrad.	Makal	Wild
4. *Citrullus vulgaris* Schrad.	Tarmuj	Cultivated
5. *Coccinia indica* (Naud.) Wight & Arn.	Telakucha	Wild
6. *Cucumis sativus* Linn.	Sasha	Cultivated
7. *Cucumis melo* Linn.	Futi	Cultivated
8. *Cucumis* sp.	x	Wild
9. *Cucurbita maxima* Duchesne	Mithakumra	Cultivated
10. *Gymnopetalum cochinchinense* Kurz.	x	Wild
11. *Lagenaria vulgaris* Seringe.	Lau	Cultivated
12. *Luffa cylindrica* (Lour.) Roem.	Dhoondol	Cultivated & wild
13. *Luffa acutangula* Roxb.	Jhinga	Cultivated
14. *Luffa graveolens* Roxb.	x	Wild

SPECIES	VERNACULAR NAME	HABITAT
15. *Momordica charantia* Linn.	Uchchhe	Cultivated
16. *Momordica cochinchinensis* Spreng.	Kakrol	Cultivated
17. *Momordica dioica* Roxb.	Bankakrol	Wild
18. *Momordica* sp.	x	Wild
19. *Mukia maderaspatana* Kurz.	x	Wild
20. *Thladiantha calcarata* Clarke	x	Wild
21. *Trichosanthes anguina* Linn.	Chichinga	Cultivated
22. *Trichosanthes cucumerina* Linn.	Banchichinga	Wild
23. *Trichosanthes dioica* Roxb.	Patol	Cultivated
24. *Zanonia indica* Linn.	x	Wild

Out of the eighteen genera available in Bengal (Prain, 1903) fourteen have been collected. Some of these species are wild, some semi-wild i.e. wild and cultivated at the same time, or cultivated but may grow uncared for near human habitation, and some others are strictly cultivated. The majority of the species grow during the rainy season, but some grow in winter, or in spring, and two or three are perennial.

A close study of the materials collected from various places reveal that a workable key for the identification of the species can be formulated from the morphological features of the leaves and tendrils. The descriptions of the leaves and tendrils have been omitted for the sake of brevity as also because they are available in BENGAL PLANTS (vol. i, Prain, 1903) and in THE FLORA OF BRITISH INDIA (vol. ii, Hooker, 1879).

KEY FOR IDENTIFICATION OF CUCURBITS[1]

A. Tendril simple
  a. Leaf entire
    b. Leaf ovate, deeply cordate at the base, denticulate, softly pubescent.............................. *Thladiantha*

    bb. Leaf slightly or deeply 5-angled
      c. Angles of the leaf not very prominent, stem soft, hairy.............................. *Cucumis*

        (i) Leaf somewhat orbicular, ovoid, dentate, softly hairy, petiole small............ *C. melo*

        (ii) Leaf slightly lobed, lobes acute hispidulous ; petiole long.................. *C. sativus*

        (iii) Leaf slightly angled, almost circular.... *C.* sp.

      cc. Angles of the leaf prominent, stem hard, hairless .... *Coccinia*
      ccc. Stiff hairs present on the leaf, petiole and stem.................................. *Mukia*

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[1] This key, prepared on the basis of the morphological characters of tendrils and leaves, is of practical value as an aid only.

aa. Leaf lobed or entire

b. Leaf 5-lobed, no hairs or very small hairs on the leaf blade.................................. *Gymnopetalum*

bb. Leaf lobed or entire, margin dentate, hairless or with soft hair, stem angular.................... *Momordica*

(i) Leaf deeply divided into 5-7 lobes....... *M. charantia*

(ii) Leaf divided to the middle or deep to the base into 3 (rarely 5) ovate or oblong lobes .... *M. cochinchinensis*

(iii) Leaf divided to the middle or deep to the base into 3 (rarely 5) lobes, lobe-apices acute, petiole channelled, glands present on the lamellated outgrowth...... *M.* sp.

(iv) Leaf more or less entire with shallow dentation .... *M. dioica*

AA. Tendril bifid

a. Leaf entire ; tendril elongated, branching occurs at the apical part, segments much smaller than the stalk.. *Zanonia*

aa. Leaf-lobed

b. Leaf deeply palmately lobed ; branching of the tendril occurs at the basal part, segments larger than the stalk .... *Bryonopsis*

bb. Leaf slightly 5-lobed, toothed, very hairy ; branching of the tendril occurs at the mid-point and the segments are almost equal to the stalk.... *Lagenaria*

AAA. Tendril variable

a. Simple to three-fid .... *Trichosanthes*

(i) Leaf margin dentate, base cordate, leaf ovate or oblong in shape............ *T. dioica*

(ii) Leaf margin entire or nearly so

* Leaf smaller, 5-angled ; generally 3-fid tendril.................... *T. cucumerina*

** Leaf larger, more or less 5-lobed (faintly) .... *T. anguina*

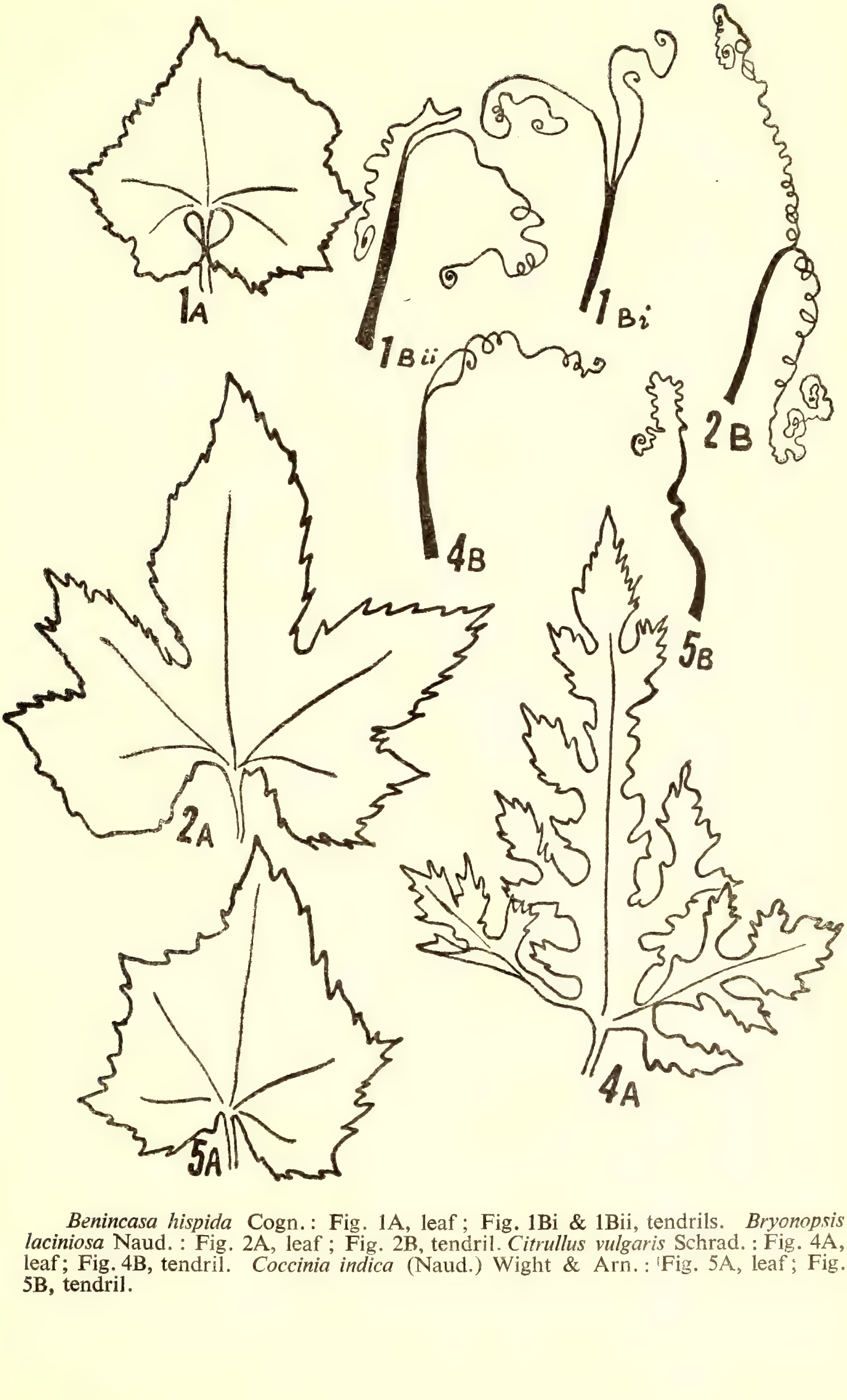
aa. Tendril 2-3 fid

b. Tendril 3-fid at the younger part, bifid at the older region ; leaf reniform, cordate at the base, slightly 5-angled............................ *Benincasa*

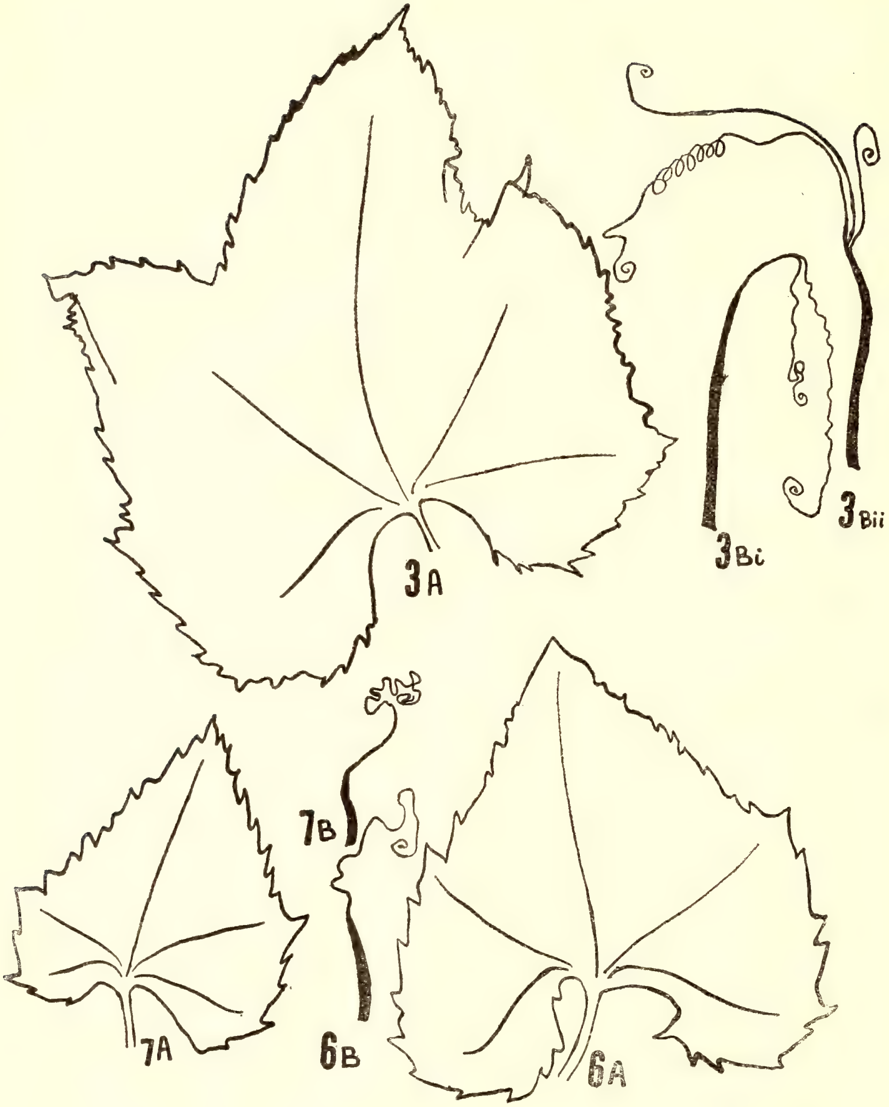
bb. Tendril segments equal or unequal, very small ; leaf deeply 3-7 lobed .... *Citrullus*

(i) Leaf hoarsely scabrid, deltoid in outline *C. colocynthis*

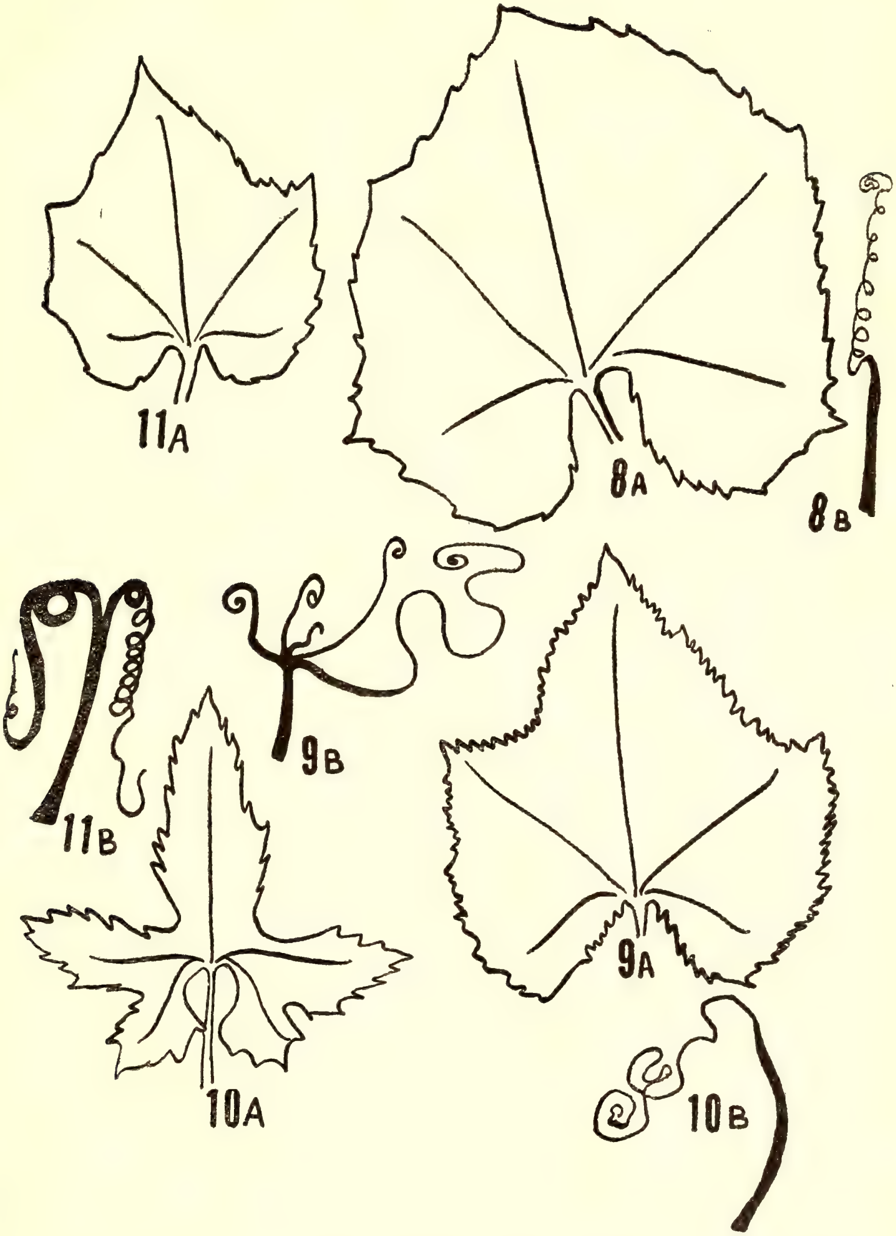
(ii) Leaf glabrous, deeply segmented, segments pinnatifid.................... *C. vulgaris*



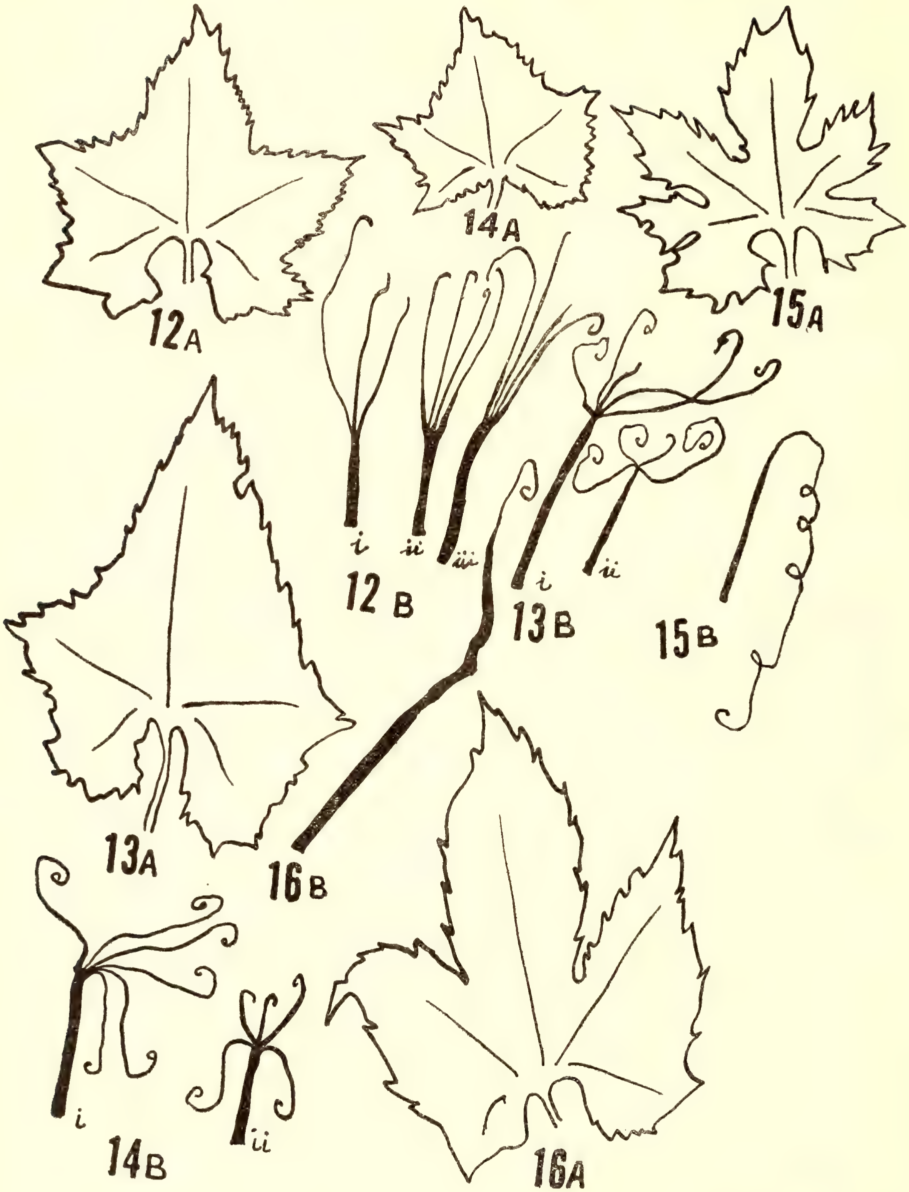
Benincasa hispida Cogn.: Fig. 1A, leaf; Fig. 1Bi & 1Bii, tendrils. *Bryonopsis laciniosa* Naud.: Fig. 2A, leaf; Fig. 2B, tendril. *Citrullus vulgaris* Schrad.: Fig. 4A, leaf; Fig. 4B, tendril. *Coccinia indica* (Naud.) Wight & Arn.: Fig. 5A, leaf; Fig. 5B, tendril.



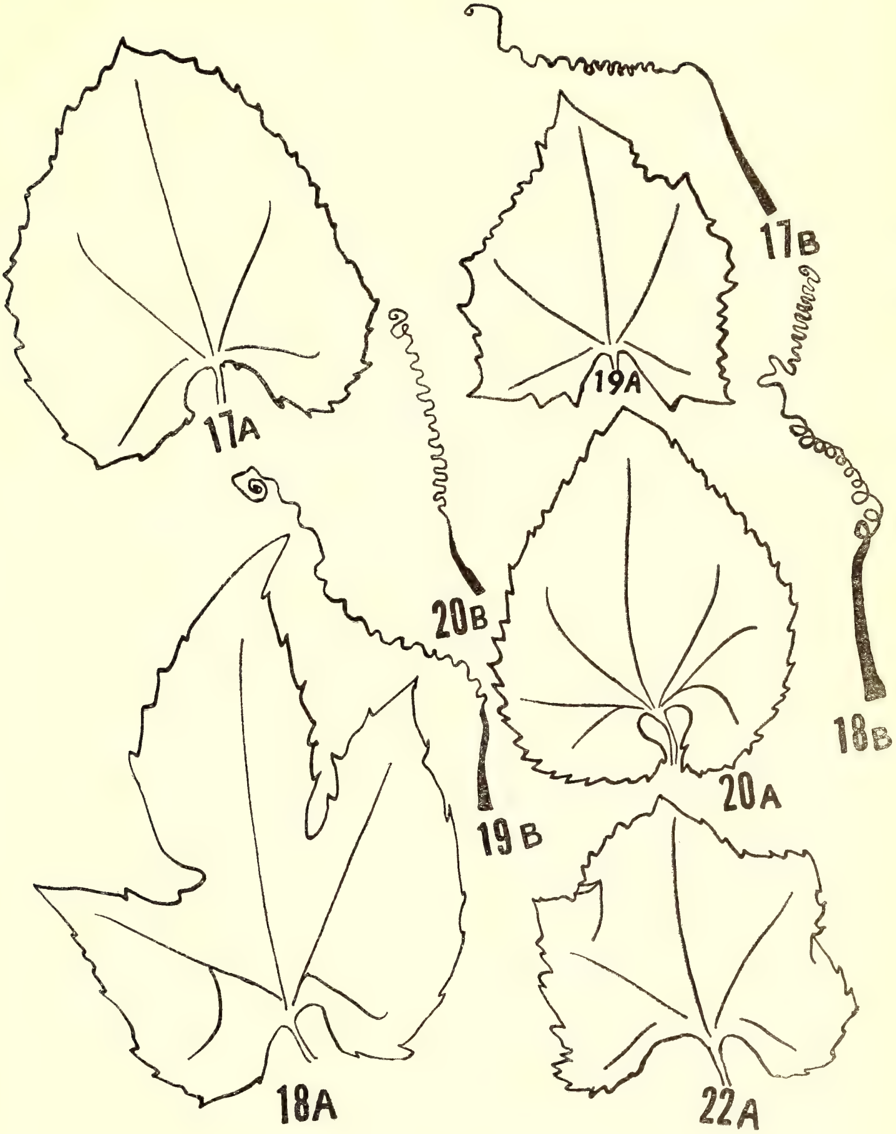
Citrullus colocynthis (Linn.) Schrad.: Fig. 3A, leaf; Fig. 3Bi & 3Bii, tendrils. *Cucumis sativus* Linn.: Fig. 6A, leaf; Fig. 6B. tendril. *Cucumis melo* Linn.: Fig. 7A, leaf; Fig. 7B, tendril.



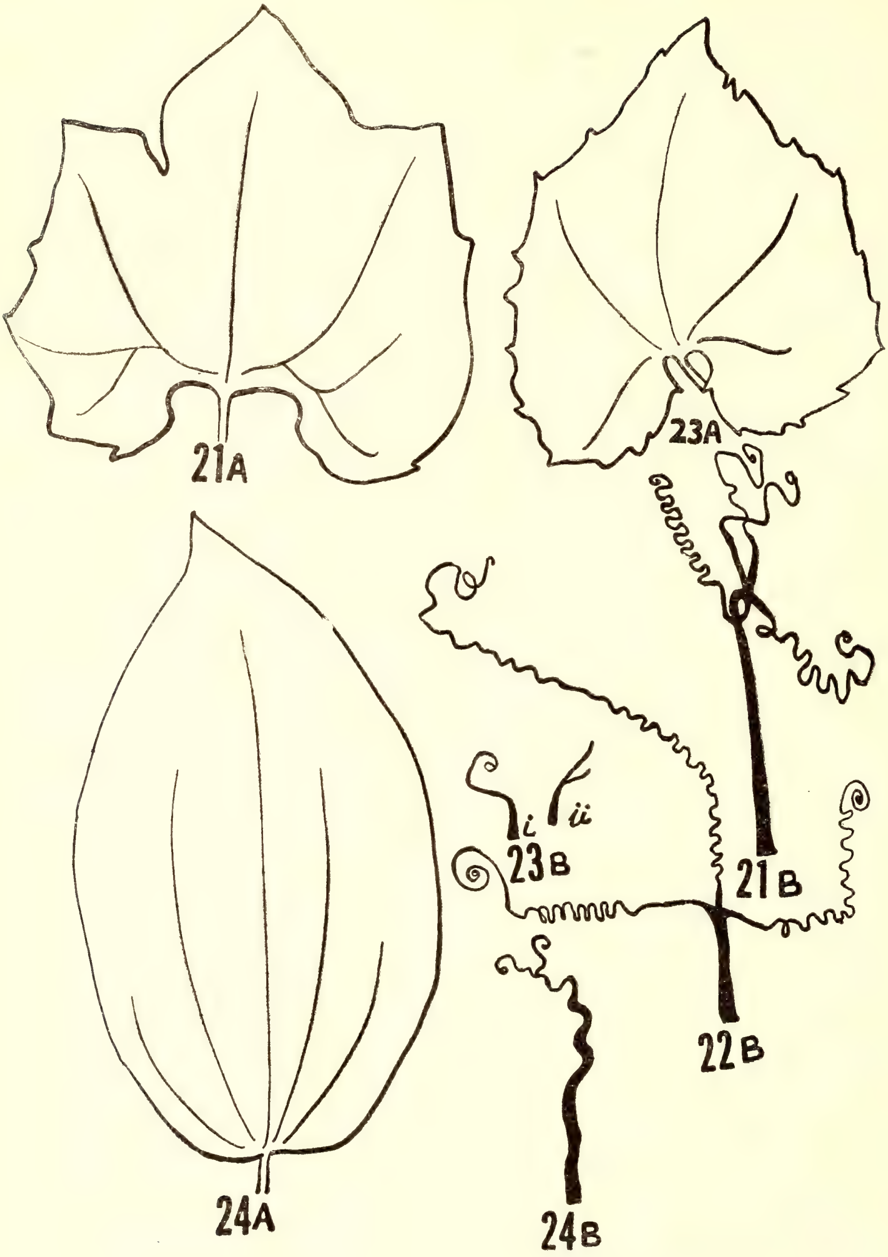
Cucumis sp.: Fig. 8A, leaf; Fig. 8B, Tendril. *Cucurbita maxima* Duchesne: Fig. 9A, leaf; Fig. 9B, tendril. *Gymnopetalum cochinchinense* Kurz.: Fig. 10A, af; Fig. 10B, tendril. *Lagenaria vulgaris* Seringe: Fig. 11A, leaf; Fig. 11B, tendril.


12A
14A
15A
i
ii
iii
12 B
i
ii
13B
15B
13A
16B
i
ii
14B
16A

Luffa cylindrica (Lour.) Roem.: Fig. 12A, leaf; Fig. 12Bi to 12Biii, tendrils. *Luffa acutangula* Roxb.: Fig. 13A, leaf; Fig. 13Bi & 13Bii, tendrils. *Luffa graveolens* Roxb.: Fig. 14A, leaf; Fig. 14Bi & 14Bii, tendrils. *Momordica charantia* Linn.: Fig. 15A, leaf; Fig. 15B, tendril. *Momordica cochinchinensis* Spreng.: Fig. 16A, leaf; Fig. 16B, tendril.


17A
17B
19A
20B
18B
20A
19B
18A
22A

Momordica dioica Roxb. : Fig. 17A, leaf ; Fig. 17B. tendril. *Momordica* sp. ; Fig. 18A, leaf ; Fig. 18B, tendril : *Mukia maderaspatana* Kurz. : Fig. 19A, leaf ; Fig. 19B, tendril. *Thladiantha calcarata* Clarke : Fig. 20A, leaf ; Fig. 20B, tendril. *Trichosanthes cucumerina* Linn. : Fig. 22A. leaf.


21A
23A
21B
22B
23B
i
ii
24A
24B

Trichosanthes anguina Linn. : Fig. 21A, leaf ; FIG. 21B, tendril. *Trichosanthes cucumerina* Linn. : Fig. 22B, tendrils. *Trichosanthes dioica* Roxb. : Fig. 23A, leaf ; Fig. 23Bi & 23Bii, tendrils. *Zanonia indica* Linn. : Fig. 24A, leaf ; Fig. 24B, tendril.

aaa. Tendril 3-6 fid .... *Luffa*

(i) Tendril generally unequally 6-fid; leaf orbicular in outline, palmately 5-7 angled, scabrid on both surfaces...... *L. acutangula*

(ii) Tendril generally unequally 3-5-fid; leaf orbicular or reniform in outline, palmately 5 (rarely 7) lobed............. *L. cylindrica*

(iii) Tendril generally unequally 3-6-fid; leaf reniform somewhat lobed, and always toothed, scabrous above .... *L. graveolens*

AAAA. Tendril 5-fid, segments all unequal...................... *Cucurbita*

DISCUSSION AND CONCLUSION

The author submits that, though most of the species available in Bengal have been considered, the present attempt is by no means complete. Of course, from this study it becomes evident that it may be possible to build up a key for identification on the basis of the morphological characters of the leaves and tendrils of cucurbits. It must be clearly mentioned here that this key is important from the practical point of view and only as an aid, and does not indicate any phylogenetic relationship of the species.

ACKNOWLEDGEMENT

The author acknowledges his gratefulness to the late Prof. G. P. Majumdar, Ph.D. (Leeds), F.A.SC., F.N.I., under whose guidance this piece of work was being carried out. The author is also thankful to the authorities of Bangabasi College who kindly allowed the facilities for his work.

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* Not seen in original by author.

Reviews

1. THE WATERFOWL OF THE WORLD. By Jean Delacour. Vol. III. Pp. 270 (24.50×18.50 cm.). Twenty plates in colour by Peter Scott; 46 distribution maps in text. London, 1959 (Country Life Ltd.). £6-6-0 net.

This volume completes the survey of all the known species of swans, geese and ducks found throughout the world, and brings to conclusion a monumental achievement. The collaboration of two such internationally recognised specialists in this group of birds has proved completely fruitful from every point of view. Both Jean Delacour and Peter Scott possess long and intimate experience of practically all the species dealt with in these three volumes in captivity, and with many in the wild state as well. They have successfully bred in their aviaries some of the rarest members of the tribe, and been able thereby to rescue—and even rehabilitate—several species from the imminent extinction with which they were faced. Peter Scott's fame as a portrayer of the duck tribe is world-wide, and his illustrations in colour of every member of it of both sexes, often in breeding as well as eclipse plumage, and of their downy young, not only lend charm and attractiveness to the volumes but are of the greatest scientific usefulness. Many of the downy young, which in various species often differ only in superficially insignificant colour patterns were quite unknown until bred in the pens of the Wildfowl Trust at Slimbridge. The plates, in effect, hall-mark the excellence of Mr. Delacour's erudite text.

The present volume deals with the five 'tribes' left over from the previous two, namely the Eiders (Somateriini), Pochards (Aythyini), Perching Ducks (Cairinini), the Scoters, Golden-eyes, and Mergansers (Mergini) and the Stifftailed Ducks (Oxyurini). The classification is mainly, as in previous volumes, that proposed by Delacour and Mayr in 1945 for the family Anatidae which, with minor modifications, is now widely accepted and adopted in scientific writings. The general order of description remains as before: first Key to the Species with a fairly full general description of each, then overall Distribution, General Habits covering ecology, breeding behaviour, courtship display, food, etc., and finally observations on the species in Captivity. This is followed by basic information in brief concerning each of its subspecies individually, treated under the same general heads as for the species. The maps in the text for each species together with its geographic races are of great help in giving a clear overall picture of the distributions, but too much accuracy should perhaps not be looked for from their small scale. On p. 47 the wintering range in India of the Redcrested Pochard (*Netta rufina*) is shown as down to about the 20th parallel. Actually this duck is a regular visitor as far south as Madras though less common than in N. India.

In spite of the somewhat deterrent cost of the volumes, the intelligent sportsman, whose interest in his kills projects a little beyond the dining table, will welcome this up-to-date authentic and well-illustrated survey of a very popular group of game birds—the duck tribe; so will the serious bird watcher and the scientific ornithologist. For every good working library of natural history of course, THE WATERFOWL OF THE WORLD is quite indispensable.

S.A.

2. MY YEAR WITH THE WOODPECKERS. By Heinz Sielmann. Translated from the German by Sidney Lightman. Foreword by James Fisher. Pp. 139 (23×16 cm.). 4 coloured and 28 black and white plates. London, 1959. Barrie & Rockliff. Price 21*s*.

Heinz Sielmann's fame as an investigator and photographer of woodpeckers rocketed into world prominence after the exhibition of his classic documentary film at one of the recent International Ornithological Congresses. Since then the film, specially edited for the *Look* television programme of the B.B.C., has been seen and admired by millions of nature lovers. The book, based on this film, was originally published in the German in 1958. It describes not only the hidden home life of several species of woodpeckers including the shy Black Woodpecker, but also the ingenious techniques devised and employed by Herr Sielmann which made the photography possible. Woodpeckers nest in holes in tree trunks and boughs, often quite deep down, and no one had as yet been able to observe what goes on within an occupied nest, let alone filming the activities. Sielmann's admirers in English-speaking countries will welcome the eagerly awaited realization of their wish to see an English translation, and a word of praise is due to the translator for the facile manner in which he has discharged his task.

Photographing inside the ill-lit interior of a woodpecker nest-hole was accomplished by means of infra-red rays, using special infra-red film. This permitted exposures to be made in complete darkness without causing any disturbance to the birds, but posed certain serious disadvantages, particularly in close-up work, which the author's ingenuity had to overcome. The photography was actually done through a pane of glass fitted in a window cut into the side of the tree trunk opposite the entrance hole. To avoid frightening the birds this had to be done bit by bit and with great circumspection during the foraging absences of the parent birds. The pictures obtained are unique, and reveal for the first time the internal economy of a woodpecker hole and the behaviour of the parents and young. Drumming and other noises and calls were sound-recorded, timed, and analysed. To supplement his photography at natural nests, the author hand-reared a number of nestling woodpeckers and later released them in a spacious aviary simulating as closely as possible the natural conditions under which the birds lived. The almost magical sequences in the film showing the exact manner in which the woodpecker employs its wormlike extensile tongue ('5 times as long as the beak' in the Green Woodpecker) to skewer out grubs of wood-boring beetles from the winding pupal galleries, were filmed under these controlled conditions. But they are in no way unnatural or 'made-up', and are without doubt some of the most superb documentary cine-shots of a bird ever made.

All in all this is a remarkable and beautifully illustrated book both for the bird lover and scientific ornithologist, as well as for the nature photographer. It lays bare in word and picture many of the hidden secrets of a woodpecker's family life and domestic economy, and demonstrates how the seemingly impossible in nature photography can be achieved by patience, perseverance, and ingenuity of technique, backed by enthusiasm and a proper understanding of the ways and habits of the subjects.

S.A.

3. A HANDBOOK TO THE COLLECTIONS ILLUSTRATING A SURVEY OF THE ANIMAL KINGDOM. London County Council, Horniman Museum and Library. Pp. 92 (18.5 × 12.0 cm.). 4 photo plates and two line drawings. Third Edition, London, 1959. Price 2*s.* 6*d.*

This is a handbook to one of the sections of the Horniman Museum, in Dulwich, London S.E., but it could as well stand on its own as an introduction to the classification of the animal kingdom, or as a summary of this to a student. In spite of having under 100 pages it combines completeness with clarity admirably. Very occasionally there are statements like this: 'In development the mollusc egg gives rise typically to a *trochosphere* larva which turns into a *veliger* larva before assuming the adult form.' Without further explanation this can hardly be very informative to the uninitiated. On the whole, however, the reader's attention is held and there is no temptation to skip paragraphs as containing only non-essential detail. Very good value at 2*s.* 6*d.* One would like to see the Museum—it must be as well planned as the handbook.

R.R.

4. CROCODILES AND OTHER PEOPLE. By Douglas Lockwood. Pp. x+222 (21.5×14.5 cm.). Cassell, London, 1959. Price 18*s*.

The author was for 10 years a newspaper correspondent in the tropical northern territory of Australia and the book is an account of some of his experiences. Though most of them are not of natural history interest, the chapters on crocodiles and buffaloes contain some interesting items.

The crocodile is *Crocodilus porosus* which is found in the Sunderbans and other parts of eastern India. Some of the areas in north Australia still hold, or at least did a few years ago, sufficient numbers to warrant their being slaughtered for their skins. The native attendants on the shikaris fed on crocodile flesh and it is said that after a week on this diet they smelt worse than alcoholic.

The domestic buffalo was first introduced into Melville Island in northern Australia and subsequently to the mainland, and it appears to have multiplied in the manner in which several introduced species have done in Australia. Their further spread has been prevented by the boundaries of desert conditions about 400 miles east, west, and south of Port Darwin, but within these limits their number is now estimated at a million. Licences to kill 2000 animals per season were issued and there are references to episodes which can only be termed 'slaughter'. The author also refers in another place to 100 kangaroos shot by spotlight in one night.

The reference to a 5 ft. crocodile jaw (which would make the animal 35 ft. long) leaves one uncertain of some of the figures, but it is interesting to read of animals familiar to us.

H.A.

5. THE WEALTH OF INDIA: A DICTIONARY OF INDIAN RAW MATERIALS AND INDUSTRIAL PRODUCTS. RAW MATERIALS. Vol. V: H.-K. Pp. xxv+332+xii (27.7×21.5 cm.). 16 plates and 169 text-figures. New Delhi, 1959. Council of Scientific & Industrial Research. Price Rs. 30.

This volume of THE WEALTH OF INDIA series carries the list of Indian raw materials from the letter H to the letter K. The list is very comprehensive and particulars of the items described are given in great detail; at the same time references are given to the authorities where fuller information may be sought. An instance in point is the section on *Hevea brasiliensis* (H.B.K.) Muell. Arg., the Caoutchouc Tree, a native of South America which has been introduced on a commercial scale into Kerala State for the production of rubber. Information is given about the climate and other conditions suitable for its cultivation, the preparation of the land for it, the alternative modes of propagation and their respective merits and demerits, various cultural operations, diseases and pests affecting the plant, methods of tapping it, processes leading up to the manufacture of raw rubber, the grading, packing, and marketing of the product, and so on. This volume includes an article on insects commencing with a general description of their structure and development from the egg to the perfect insect, their classification and distribution, their nuisance value as pests or vectors of disease, methods of control, and in order to make the picture complete a description of the insects which are beneficial as pollinators or as predators or as pests of noxious weeds, animals, and other insects. The book is illustrated with well-chosen and well-reproduced pictures and drawings. With the subject matter treated so elaborately the publication, which has already reached its fifth volume, promises to be beyond the purse of the ordinary reader. It is a valuable book of reference which should be in every library. Having so much to interest the general reader, it is to be hoped that the libraries will keep it where it will catch the eyes of such readers and excite their curiosity.

There are in the book passages which I would like to see omitted. For instance, the authors tell us about a certain animal that, in the Punjab, 'the flesh is said to be pounded with ghee into an ointment for application to chronic ulcers' and that 'exposure to fumes from the burnt spines is believed to relieve pain due to haemorrhoids'. Is it necessary to condemn these creatures to death by such statements unless these remedies have been tried and found to be efficacious?

D.E.R.

Miscellaneous Notes

1. POSSIBLE FUNCTION OF THE TIGER'S WHISKERS

It is a well known fact that the sense of smell of both the tiger and the leopard is very poorly developed. I have seen plenty of evidence for this in my own experience, and I do not think that any experienced big game hunter or naturalist will dispute this. And yet both these animals live by stalking and killing those animals (herbivores) whose sense of smell is very strongly developed. The tiger and the leopard therefore have learned over the course of centuries that if they are to succeed in killing the animals they eat, they must make due allowance for the latter's sense of smell, i.e. before the final fatal assault they must approach their quarry from a down-wind direction. Strangely enough a man-eating tiger or leopard will take the same precaution when stalking a human being! Old habits and instincts die hard. Now every hunter who has hunted bison and buffalo on foot, or even tried to stalk chital or sambar, knows how difficult it is very often inside the jungle to know or find out the direction of the wind. How does a tiger or a leopard find this out in a similar situation? They have the added difficulty of being much lower on the ground while stalking.

It is my belief that they do it with the aid of their very long whiskers. These long filaments, which are as thin as human hair at their tips—gradually thickening inwards till they become quite thick and stiff at the roots—act like so many delicate antennae which together constitute a very effective wind gauge. The slightest movement of the fine tips is carried to the stiff roots and thence to the sensory nerves of the upper lip. Could one think of any other biological reason or use for these very peculiar and prominent whiskers in the 'great cats'? I suppose the final test of the theory could be carried out if one could cut off the whiskers of a tiger and then see if he could make use of the wind in his hunting—but I have not been able to do that!

56 A.P.O.,
January 12, 1960.

M. M. ISMAIL,
Lt.-Col., I.A.

2. THE PRESENT STATUS OF THE INDIAN LYNX (*CARACAL CARACAL*)

I have read with interest Sri N. N. Sen's note on the Caracal or the Indian lynx (*Caracal caracal*) published in the August 1959 issue of your journal (**56**: 317). I saw and shot a caracal in the Saharanpur Forest Division, Uttar Pradesh, in May 1955 under somewhat interesting circumstances. I was staying in the Beribara Forest Rest House and had gone out for an early morning *ghoom* on an elephant. While we were going through scrub forest I saw a male partridge scuttling some fifty yards ahead of the elephant across an open bit of grassland. The partridge disappeared into a tuft of high grass. Immediately afterwards I saw a lithe fawn-coloured body spring into the air in a graceful arc. It looked too light-coloured and elongated for a jackal and I took the elephant near the tuft of grass to investigate what it was. On reaching there I found that the animal had caught the hapless partridge and had already plucked almost all the feathers from its breast. As the animal was neither a jackal nor a wild cat I shot it in order to identify it. One shot with a .22 long rifle cartridge at the base of the skull despatched it.

When we collected the animal I could see that it looked very much like a lynx, pictures of which I had seen in various books. I brought the carcase to the rest house and was able to identify it with the help of a book on Indian animals. I also enquired from the local people who said the animal was called *siyah gosh*, which means 'black ears'. This corresponded with the Hindustani name given for the Caracal in the book of words, as also with the fact that the animal had a pair of black and very pointed ears. The face and body were cat-like but the tail was proportionately shorter and ended in a little pom-pom. The colour of the body was light fawn and the undersides white. The ears were much longer than in the felines and were pointed at the tips which ended in thin plumes of one inch-long black hair. The size of the body was about the same as a jackal's, but it was lower and therefore looked slightly more elongated.

There is an interesting postscript to the tale. After collecting the caracal I asked my orderly to collect the partridge, as I was not averse to eating a partridge freshly killed by the caracal even though it was the close season. To our surprise, when the orderly went to pick it up the partridge got up and ran into the nearest bush, looking for all the world like a young lady who is surprised without any clothes on, and rushes headlong into the nearest cover! That is the last we saw of that partridge. I still wonder if he grew a new set of breast feathers.

CONSERVATOR OF FORESTS,
TEHRI-GARHWAL CIRCLE, UTTAR PRADESH, B. P. SRIVASTAVA
DEHRADUN, U.P.
November 24, 1959.

3. TODDY CAT (*PARADOXURUS HERMAPHRODITUS*) AND RUSSELL'S VIPER (*VIPERA RUSSELLI*)

On the morning of 30-11-1959 while motoring through the forest on the Mysore frontier road, I found on the roadside a toddy cat and a large Russell's viper lying dead just opposite each other. The deaths were recent as rigor had not yet set in. The snake had been bitten on the head, the neck, and the tail below the vent; the rest of the body bore no teeth marks. The toddy cat had been bitten on the head near the ear. Obviously they had been fighting with fatal results to both. What is the reason for this jungle tragedy? Will the Editors or any of my readers make a suggestion?

I know small birds and mammals are included in the menu of these palm civets, but why did it tackle this stout, five-foot long Russell's viper, a most venomous antagonist? Vice versa could the snake have taken the aggressive role? This appears improbable in view of the fact that the palm civet was 3 feet 4 inches long and weighed 6 lb., rather too big for the snake to swallow.

Probably they met suddenly and a fight ensued. The snake's venom acted quickly resulting in the death of its opponent on the spot and the snake itself died there from the several bites on its head and neck. Or the toddy cat having formerly successfully tackled smaller and harmless snakes attacked and killed the Russell's viper and carried it to the roadside where it died in its turn.

15 PERUMALKOIL STREET,
FORT, COIMBATORE, B. SUBBIAH PILLAI
December 15, 1959.

4. BATS AS A STORM SIGNAL ?

The writer had a novel experience on the evening of 27 May 1959 Eight Indian Pigmy Pipistrelles, *Pipistrellus mimus* Wroughton, were being observed in the Chandpole area in Jaipur City. At about 7.35 p.m. all the pipistrelles which were flying their characteristic flight with quick jerks and descents disappeared; evidently they took shelter in their roost, a small hole in the wall of a near-by house. I waited for 10 minutes wondering about the reason for their disappearance. At about 7.55 or 8.00 p.m. Jaipur was struck by a high speed storm which lasted for two hours and uprooted many trees.

On the evening of 28 May 1959 there was no sign of any storm but the pipistrelles again disappeared at 7.40 p.m. It struck me now: is the disappearance of the pipistrelles forecasting a storm? Immediately I cautioned my family members against the possibility of a storm and exactly at 8.05 p.m. Jaipur was struck by a devastating storm which uprooted thousands of trees, blew away hundreds of tin sheds, and killed many cattle.

On 30 May 1959 I got another opportunity of verifying that the disappearance of the pipistrelles is an indication of storm. When the pipistrelles disappeared this evening, I announced with confidence a coming storm; at 8.10 p.m. we had a very fast-moving storm which took many lives in addition to causing other destruction.

Can we not make use of the pipistrelle as an indicator of coming storms?

DEPARTMENT OF ZOOLOGY,
MAHARAJA'S COLLEGE,
JAIPUR,
July 24, 1959.

ISHWAR PRAKASH

5. OCCURRENCE OF THE SEA COW, *HALICORE DUGONG* (ERXL.), OFF THE SAURASHTRA COAST

The landing of two sea cows at Bedi Bunder recently caused considerable interest among the members of the public, leading to a report in the press.

The first of these was sighted dead and floating in the sea near the Kalyan lighthouse on the 17th July 1959 by a fisherman who cut it up into four pieces and towed it to Bedi village, intending to market its flesh. As it had no sale, it was thrown away. Only the head with the fore-limbs and a piece of the abdomen were found two days later.

A second specimen, a female 13′-4″ in length and weighing a ton, was landed on the 30th July by the same fisherman. This time, however, it was retrieved intact by the staff of the Fisheries Department. Attempts to preserve it were unsuccessful and only the skull was ultimately recovered.

The head of the animal was truncate and covered with thick bristly hair. The mouth was ventral with very thick upper and bilobed lower lips, both covered with hair. No teeth were visible, but hard calcareous protrusions could be felt inside the lips. The eyes were small and laterally placed. There were a pair of axial mammae about 3″ in diameter. The stomach contained some filamentous algae.

The underside of the animal was whitish grey, becoming darker dorsally.

The skull of one of the above specimens is preserved at the Bombay Natural History Society.

Ellerman & Scott, in CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS, record the distribution of the dugong as 'seas of Protuguese East Africa, Madagascar, Mafia Island (off Tanganyika), Kenya, the Red Sea, coasts of Malabar, India, Ceylon, the Andaman Islands and Mergui Archipelago, Riukiu Is., Formosa, Malaysian Seas, Philippine Is., and Northern Australia.'

Blanford, in the FAUNA OF BRITISH INDIAN—MAMMALIA (p. 594), records its occurrence on the coasts of the Indian Ocean in Africa and India up to the 15th degree latitude.

This relation of the sea lions and seals is reputed to use its fore-limbs as hands for conveying food to the mouth, and is said to carry the young pressed to the breast with the flippers. This, together with the pectoral position of the mammae, is said to account for the mermaid legend.

A live dugong of 160 cm. length is reported to have been kept in the aquarium of the Central Marine Fisheries Research Station at Mandapam Camp.

DEPARTMENT OF FISHERIES,
TARAPOREVALA AQUARIUM,
BOMBAY 2,
December 23, 1959.

S. B. MANI

[These Saurashtra specimens extend the recorded distribution of the Dugong in India to north of the 15th parallel. Bedi (Jamnagar) is *c.* 22° 30′ N.—EDS.]

6. WILD LIFE PROBLEMS

Mr. Humayun Abdulali's notes on Wild Life in the *Journal of the Bombay Natural History Society* (Vol. **56** (2): August 1959) make sad reading. The disillusioning thing is that it is not only in Madhya Pradesh that these conditions prevail. They seem to be common all over the sub-continent.

I often wonder whether we are not fighting an almost impossible battle in trying to protect the wild life of our country. I am a tea planter and I live in the High Ranges of Kerala and I have had the opportunity of studying this protection problem at close quarters. I have come to certain conclusions and quote them for your perusal.

1. The vast majority of our people have never heard of the Indian Board of Wild Life, do not know what it stands for, and have no idea about the work it is doing.

2. The vast majority of our people have yet to develop a genuine interest in wild life. I mean sufficient interest to worry about its welfare.

It is highly idealistic to expect a man to treat the Great Indian Bustard with respect when he does not know what the bird looks like, has no appreciation of how it is being rapidly wiped out, and does not understand why we wish to prevent its extermination. To the miscreant his bustard is a goodly bird that will do well for the evening's pot. Similarly, I know of numerous cases of Junglefowl, Spurfowl and Painted Bush Quail snared in traps in the tea and jungle in these hills nearly all the year round. I have watched shot guns go after these birds with the same degree of indiscrimination. I have seen Rainbow Trout floating on our waters after being poisoned. I have seen how a species of mountain goat has been nearly exterminated in these hills. I have known of health-crazy parties going out to slaughter our Black Monkeys for medicinal purposes. I have heard that a flourishing trade in bison meat exists in the foothills of the High Ranges. I was not surprised to read that Mr. and Mrs. T. H. Basset were 'horrified to see two figures carrying rifles' in the Periyar Sanctuary. This is typical of what goes on all the time.

3. It does not matter how many big names are associated with our Wild Life Board. What is important is the influence it has in successfully getting the State Governments to adopt and enforce its resolutions.

4. One Wild Life Week a year is totally insufficient for our needs. What we need is a Wild Life Century in our country.

5. The Wild Life Board and a Society like ours must make concerted attempts to educate our people about natural history. How

we can do this is best left to a subcommittee and to interested educationists. Personally, I think it calls for more emphasis on nature study in our school curricula from the earliest stages.

6. Steps must be taken to see that poachers are really severely punished. There is no point in passing resolutions and making laws if they cannot be enforced.

In the final analysis it all depends on whether we, as a people, want to save our wild life or not. If we do not there is very little that Societies and individuals can do in the matter.

PERIAVURRAI ESTATE,
MUNNAR P.O., M. A. KHAN
KERALA STATE,
S. INDIA,
November 22, 1959.

[We fully agree with our correspondent that so far the Indian Board for Wild Life has not been conspicuously effective in the purpose for which it was constituted. Reports from all over the country continue to confirm the fact that the wild life position is steadily deteriorating; poaching and illicit misuse of crop protection guns, and illegal practices of every kind are on the increase. The members of the Board have stressed again and again, at each successive meeting, that perhaps our most pressing need at the present time is publicity and educating the public to realize that our wild life is a national asset.

As our correspondent points out, it is quite true that the vast majority of people are unaware of the very existence of the Wild Life Board and of the work it is intended to be doing. In a country where literacy is as low as in ours, the only effective way of educating the public on the problems of wild life and the need for its protection would seem to be the movie film. Every successive meeting of the Board has reiterated the urgent need for film documentaries on Indian wild life for countrywide 'plugging' in cinemas in an earnest attempt to awaken interest in the problem. Yet, today, eight years after the formation of the Wild Life Board, we are not aware that any such film has been produced by the Films Division. If such a film has been produced the secret has been well kept. We have not heard of any one having seen it. The Society has certainly never been consulted about its making as one would reasonably have expected. It is obvious that the high ups both in the Central and State governments are not seriously interested in the problem. Otherwise it is inconceivable that so little would be done about it.

It is a disheartening state of affairs and we can sympathize with the pessimistic note struck in the last para above.—EDS.]

7. THE FOREST WAGTAIL, *MOTACILLA INDICA* (GMELIN), IN MADRAS, CHINGLEPUT DISTRICT

The Forest Wagtail is an interesting winter visitor to Ceylon and the Western Ghats, arriving by about October and leaving by about March for its summer quarters in eastern Siberia, the hills of northern China and Assam where it is supposed to breed. But since its records on the eastern side of peninsular India are comparatively rare, it was earlier conjectured that like many other east-Asiatic migrants, this also reaches its winter quarters in western India, by way of the Andamans rather than through the Eastern Ghats.

On the eastern side of the Peninsula, it is recorded by Ball (*Stray Feathers* **7**: 219) in the Godavari Valley; Jerdon saw it (Birds of India **2**: 227) at Nellore, and Dewar (*J. Bombay nat. Hist. Soc.* **16**: 490) noticed it twice at Madras. However, it was not procured by the Vernay Scientific Survey of the Eastern Ghats, though Sálim Ali noted (ibid. **36**: 909) a pair at Munanur on the 12th October and one at Farahabad on the 17th October 1931, both localities rather in the interior of Andhra Pradesh (Hyderabad State). Fuller observed it at Poondy near Madras on the 29th September 1956.

Recently for about 20 days, from the 19th September till the 7th October 1959, I saw almost every day, about 7 or 8 of these Forest Wagtails feeding singly scattered throughout the estate of the Madras Christian College, Tambaram. This is about 16 miles south of Madras, but only about 7 miles across to the east coast. The college estate is about 300 acres of scrub jungle, continuous with the Vandalur reserve forest, with clearings here and there only, for the college buildings, playing fields and a number of forest footpaths.

These wagtails were usually seen in the cooler part of the evenings or at cloudy parts of the day, always singly, busily running about in shade, feeding across the footpaths, or sometimes in the wayside grass, or even getting into the adjacent bushes pursuing their food. They walk about a lot with a slight forward swing of the head, stopping now and then to swing their tail and the whole hinder part of the body sideways in a very characteristic manner. It is difficult to identify them readily, but they are extremely unmindful of the passer-by, so that one can safely approach them even to about ten feet and observe them at leisure without much difficulty. When disturbed, they fly off with a loud *spink spink* note to the nearest tree, coming down almost at once and alighting elsewhere on the ground.

The Forest Wagtail was recorded for the first time at Tambaram by Shri Gift Siromoney (*J. Bombay nat. Hist. Soc.* **56**: 637). His record doubtless refers to the same birds as mine which sojourned in the locality for about 20 days. 19th September is probably the earliest record of this east-Asiatic migrant in peninsular India. Moreover, it *may* suggest that the Forest Wagtail regularly passes down the eastern side of the Peninsula before reaching its winter quarters on the west. More observations at the appropriate season are called for.

Department of Zoology,
Madras Christian College,
Tambaram,
December 20, 1959.

P. J. SANJEEVA RAJ

8. THE ADJUTANT STORK, *LEPTOPTILOS DUBIUS* (GMELIN), A DESTROYER OF LOCUSTS IN RAJASTHAN

The Adjutant Stork [*Leptoptilos dubius* (Gmelin)] appeared singly as well as in large groups of about 2000 (*sic*) in the villages Rayanwali, Thukrana, Freedsar, and Kardoo of Suratgarh tehsil of Sri Ganganagar district on or about 14 August 1956. It was learnt from villagers over 60 years old that the visit of the Adjutant Stork (local name *Nalia*) to this area was an uncommon feature. About four decades back some birds of this species had appeared but not to the extent seen during August 1956. The unusual appearance of the bird and in such vast numbers was presumably due to large patches of concentrated breeding of solitaries of the Desert Locust in a gross area of about 50 square miles during July-August 1956, on which the birds were found preying. During the same season concentrations of a number of grasshoppers of various species also occurred at several places in the desert area of Rajasthan. The birds were observed preying in the early morning on the hoppers and fledglings of the Desert Locust, the Migratory Locust, and the grasshoppers, which were inactive at that time. Peculiar methods were adopted by this bird in preying on hoppers and adults. It would run a few steps flapping its wings briskly to beat the bushes of phog, *Calligonum polygonoides* Linn., and bauwli, *Acacia jacquemontii* Benth., on which large congregations of the hoppers and fledglings of the Desert Locust were noted to be resting in the morning. Disturbed by the heavy and noisy flaps of the wings the insects jumped down from their roosting places, when they were immediately attacked with the wedge-shaped bill, picked up, and devoured. After taking a heavy toll of various species of locusts and grasshoppers, the birds were observed to rest during the afternoon, squatting on the ground with the shanks extended well in front and the head drawn in between the shoulders. In the evenings they became active again and resumed feeding. Their food in this area appeared to be restricted mostly to the various species of Acrididae. It was further observed that the birds selected roosting places high up on the sand dunes which were devoid of vegetation, but as these places were very near to the infested area they usually remained localized here for three to four days. The flocks disappeared on or about 21 August 1956.

LOCUST OUTPOST,
CHURU,
RAJASTHAN,
February 17, 1959.

GURDAS SINGH
CHARAN SINGH

9. ADDITIONS TO THE BIRDS OF COIMBATORE, SOUTH INDIA

I have recently obtained some birds around Coimbatore which are relatively rare in southern India and which may be worth recording.

Limosa limosa limosa (Linnaeus): The Blacktailed Godwit

On 18-10-59, my son shot a solitary bird which was in the company of 5 or 6 Greenshanks, *Glottis nebularia* (Günnerus) on the edge of a tank about 18 miles from Coimbatore. He noted that though often driven away by the Greenshanks it was reluctant to leave and kept with them. This is the first time I have seen the bird here in my experience extending over 40 years.

Demiegretta asha (Sykes): The Indian Reef Heron

One was shot on 19 November 1958.

Both the above birds have been examined and identified at the Bombay Natural History Society.

15, PERUMALKOIL STREET,
FORT, COIMBATORE, S. INDIA,
November 6, 1959.

B. SUBBIAH PILLAI

10. BIRD MIGRATION IN INDIA

Recovery of Ringed Birds

No.	Date and place of ringing	Species	Ringed by	Date and place of recovery	Reported by
Moskwa 37558 B	22-6-1956. Zapovednik of Astrakhan, Volga delta, 46° 14′ N., 49° 2′ E.	*Platalea leucorodia*	Bird-ringing Bureau, Moscow	16-7-58. Balkhandia tank, Piplu village near Tonk. *ca.* 26° 9′ N., 75° 58′ E.	Sahibzada Abdul Munim Khan
Moskwa E 556085	17-7-1959. Kurgaldzhin Lake (*ca.* 50° 30′ N., 69° 35′ E.), *ca.* 150 km. SW. from Akmolinsk, Kazakh S.S.R.	*Anas crecca* ♂ ad.	Bird-ringing Bureau Moscow	30-12-1959. Bandha Lake, 38 miles west of Partapgarh, Faizabad Division, Uttar Pradesh. *ca.* 26° N.; 82° E.	S.I. Moosa Qasim

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
February 26, 1960.

EDITORS

11. FURTHER ADDITIONS TO THE BIRDS OF KUTCH

The Bombay Natural History Society's Bird Migration Study project conducted by Dr. Sálim Ali in the spring this year has added one more species to the existing list of the birds of Kutch, and two more specimens of a rare migrant to the bird collections of the Society. This rare migrant is

Hypocolius ampelinus Bonaparte
♀ collected on 22 March 1960
♂ collected on 23 March 1960

both at Kuar Bet, *c.* three miles from camp.

The diminishing daily catches prompted Dr. Sálim Ali to issue instructions to the field party on the night of the 20th to put up the nets farther afield than was being done till then. One such operational wing was put in charge of Dr. R. M. Naik of the Faculty of Science, Baroda, (one of the participants in the field team) and myself, and was located about 3 miles from the headquarters.

A beginning was made at this location on the 21st, but the day ended with the commoner birds being caught. On the 22nd at about 3.45 p.m. I found a bird, which I had neither seen earlier in the field nor at the time could recall having seen a specimen of in the Society's collections, entangled in one of the nets. It was carefully taken out and brought to camp where Dr. Sálim Ali revealed its identity to us as the female of *Hypocolius ampelinus.* The skin of this rare migrant was prepared for the Society's collection. While doing so its crop was examined and found to contain about 20 berries of *Salvadora persica.*

Enthused by the previous day's catch of a rare migrant we fixed the nets at the same spot on the 23rd. At about 3.30 p.m. another unrecognizable bird was seen by me perching on a *Salvadora* bush-top about 10 feet from one of the nets. It was busily feeding on its berries. Dr. R. M. Naik and myself now took upon ourselves the seemingly risky job of driving it into the nets, and getting it entangled. Rounding the bush it had perched on we placed the bird between ourselves on one side and the nets on the other. Scared by our presence it flew in the direction opposite to us and got entangled in one of the nets. When back at the headquarters with this specimen Dr. Sálim Ali told us that it was the male of *Hypocolius ampelinus.* Our difficulty in placing this second bird either in the field or when in hand was due to the fact that the female (a specimen of which we had seen the previous day) differs from the male in the absence of the black stripe from the lores, through the eye which widens to a broad band on the nape.

Solitary vagrants of this migrant are recorded from West Pakistan, Makran Coast, Khalat, Sind, Madhya Pradesh, and Bombay. In the Society's collections there are in all 15 specimens (10 ♂♂ and 5 ♀♀) of which only one has been taken in India. This is the one collected by Dr. Sálim Ali at Kihim, Kolaba District, Bombay on November 14, 1930, and reported in Vol. **34**: 1061 of the *Journal.* The rest come from the Middle East. The above two skins, now preserved in the bird collections of the Society, bring the total of specimens of this rare migrant collected on Indian soil to three.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
April 12, 1960.

P. B. SHEKAR,
Field Collector.

[Another species added by the migration study field work to the Kutch list is the Whitefronted Finch-Lark, *Eremopterix nigriceps affinis* (Blyth). Two examples of this were taken in the nets, a third collected and preserved, and several others observed. On Kuar Bet this lark seemed to replace the commoner blackbellied species (e.g. *grisea*) of the less desert portions of Kutch.—EDS.]

12 CAN SNAKES PRODUCE VOCAL SOUNDS?

In the *Journal* (**55**: 578) I referred to vocal noises made by the Dhaman (*Ptyas mucosus*). Yesterday morning while shooting grey quail not far from Bombay we put up a large Dhaman in a dry paddy field.

As it rapidly glided away I had to tread on its tail and touch it with my gun barrels several times before it stopped and turned to attack. Till then we were mostly on and along a 3-foot high bund which perhaps prevented the snake from raising itself high enough to strike. When at bay several inches of neck and body behind the head were noticeably dilated and the snake uttered a very audible *aonh* which at a few feet sounded like a low growl. Others in the party who were 12 to 15 yards away also heard the noise, but Mr. Krishna Talcherkar told me afterwards that it sounded mournful to him.

The snake was captured without any physical injury having been inflicted upon it and there can now be little doubt that this species when angry (?) can emit a noise.

Clifford H. Pope in THE REPTILE WORLD (1957): 138 writes: 'Many snakes produce an alarming effect as in the cobra by inflating as well as flattening the body. Hissing is usually combined with these processes. The bull snakes (*Pituophis*) of North America blow air against a fleshy flap that rises just in front of the windpipe and thus make a surprisingly loud sound.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
December 7, 1959.

13. DISTRIBUTION OF THE SKINK, *RIOPA LINEATA* (GRAY)

I recently received from Prof. R. V. Seshaiya, Director, Marine Biological Station, Porto Novo, south India, three specimens of the Fourtoed Skink, *Riopa lineata* (Gray), obtained at Annamalai Nagar, Chidambaram District, Madras State, during 1955 when phenomenal rains inundated the University buildings.

This species appears to have been recorded only from the Bombay State between Poona and North Kanara (Smith, FAUNA, 1935), but in the Society's collection there are also some specimens obtained on Salsette Island, Bombay. The Zoological Survey of India inform me that they have specimen (?) from Madhya Pradesh.

Anyhow the above specimens appear to extend the known range of this species very considerably.

NATURAL HISTORY SECTION,
PRINCE OF WALES MUSEUM, V. K. CHARI,
BOMBAY 1, *Curator.*
November 1, 1959.

14. A NOTE ON THE AMPHIBIANS OF KUTCH

All that is known of the meagre amphibian fauna of Kutch is from specimens in the collection of the Bombay Natural History Society and from the records given in FAUNA OF BRITISH INDIA, by Boulenger (1890), VERTEBRATE ZOOLOGY OF SIND, by J. A. Murray (1884), and C. McCann's list of amphibians of Kutch (1939, *J. Bombay nat. Hist. Soc.* **40**: 425-427).

During a recent field trip (late September and early October 1959) the following were collected by me:

ORDER BATRACHIA

Family RANIDAE

Rana cyanophlyctis Schneid.

Locality: Bhuj, in small pools of water and 3 in the residential quarters at night. [A well of brackish water *c*. 5′ across at Kuar Bet on the borders of the Rann visited in March 1960 held large numbers which covered the entire surface and crept into the crevices when disturbed. The water was about 6 ft. below ground level.]

Rana tigrina Daud.

Locality: Bhuj and environments.

Rana limnocharis Wiegm.

Locality: Bhuj, in small pools of water and 2 in the residential quarters at night.

Rana breviceps Schneid.

Locality: Bhuj and environments. The specimen collected did not have the tubercle at the tibiotarsal articulation found in some specimens from south India [See J. L. Bhaduri & Mira Kripalani (1954): *J. Bombay nat. Hist. Soc.* **52** (2 & 3): 620-623].

Microhyla ornata Dum. & Bibr.

Locality: Bhuj, in small pools of water calling at night.

Family BUFONIDAE

Bufo andersonii Boulenger

Locality: Bhuj, all over the town on roads and in the residential quarters at night.

Of these species three (*Rana limnocharis, Rana breviceps,* and *Microhyla ornata*) are additions to the comprehensive list published by Mr. McCann.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6.
March 30, 1960.

P. W. SOMAN,
Junior Research Assistant.

15. *LAELIA ADALIA* SWINHOE (*LAELIA EXCLAMATIONIS* KOLL.) (LYMANTRIIDAE: LEPIDOPTERA): A NEW PEST OF GUINEA GRASS IN SOUTH INDIA

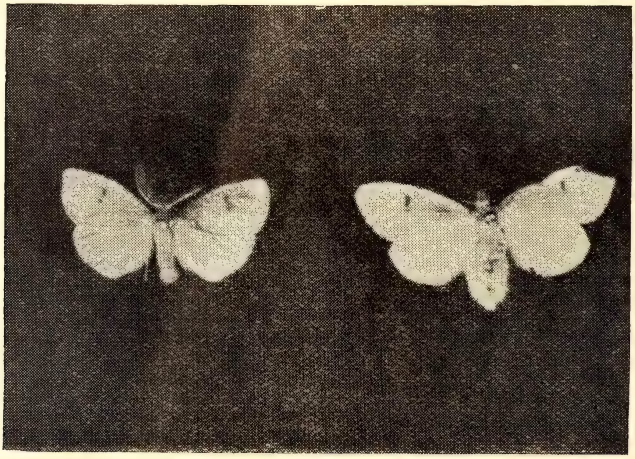
(*With a photograph*)

INTRODUCTION

Guinea grass (*Panicum maximum*) is a perennial grass, which has of late become extremely popular as a succulent and nutritious green fodder, particularly for milch cattle. A few municipalities have ventured to cultivate this grass, among which Madurai deserves special mention. A small beginning appears to have been made during 1927 and the area has been gradually extended up to 128 acres at present, ensuring a steady and uniform supply of this excellent fodder.

Recently, a hairy caterpillar *Laelia adalia* Swinhoe (*Laelia exclamationis* Koll.) was found to occur in large numbers and devastate the crop. Hampson (1892) mentions of this species as occurring in NW. Himalaya, Sikkim, and throughout India and Ceylon, without details of either the actual distribution in the South or the host plants.

As this is the first record of the species occurring in a serious form in south India, a short account on its incidence, life-history, etc., may be of some interest.



Laelia adalia Swinhoe (*Laelia exclamationis* Koll.)
Left: Male moth ; Right: Female moth. (About actual size)

THE PEST AND ITS SEASON OF INCIDENCE

The caterpillars appeared first in pest form at the Municipal Sewage Farm, Madurai, during May 1950 and continued with unabated virulence till July. A recrudescence of the pest was noted during December 1952 and the incidence was protracted till February 1953. The next outbreak was noted during November 1958, after a lapse of five years. The severity of the damage was heavier than before and continued till February 1959, there being three distinct and successive waves of the caterpillars.

NATURE AND EXTENT OF DAMAGE

The caterpillar is a leaf feeder. It hides between the tillers in the lower portion of the clump during the day and comes out late in the evening or early in the morning to feed on the leaves. The damage inflicted is terrific since the entire crop is defoliated.

The estimated loss of the crop in money value due to this pest during 1952-53 has been computed to be about Rs. 12,000, and during 1958-59 about Rs. 15,000.

LIFE-HISTORY

The moth lays its whitish spherical eggs on the plants in groups of 3 to 6. The caterpillar is fleshy and stout, with hairs all over its body. The first five and the last abdominal segments are dark-coloured and provided with dark tufts of hair on the dorsal side. Other segments are yellowish, with brownish hairs. The head is small and light brown. The full-grown caterpillar measures about 3 cm. in length. Pupation takes place between the interspaces of the tillers in the lower portions of the clumps, inside a dark brown oval cocoon of silk. The moth is stout with plumose antennae. The wings are brown in colour, with four spots in a line in the middle of the forewing (Photograph). The life-cycle is completed in about a month.

ALTERNATIVE HOSTS

The pest was observed to feed only on guinea grass, though extensive areas of cereal crops like paddy, ragi, etc., were available near by. It has been recorded as affecting Casuarina in Andhra State by Perraju *et al.* (1959).

CONTROL MEASURES

The onslaught of the insect during 1950 was so sudden that no control measures could be contemplated. During 1952-53, B.H.C. and toxaphene were applied as 0.1% sprays, but the results were not satisfactory. As an alternative, the stubble was burnt in small blocks and the crop was replanted in fresh areas.

During 1958-59, B.H.C. 10% dust was tried, but only the earlier instars of the caterpillars were found susceptible. The grown-up caterpillars were not affected and they pupated normally. Such pupae were parasitised by the hymenopterous parasites, viz. *Tetrasticus* sp. and *Hockeria* sp. to an appreciable degree.

The treatment of the pest with B.H.C. during earlier instars does not seem to have affected the parasitation and development of these endoparasites.

Guinea grass being a fodder crop, the insecticides had to be used with due precautions and their application was meticulously stopped four weeks before the cutting. By feeding the grass after this period no deleterious effect was noticed on the cattle.

ACKNOWLEDGEMENTS

Our thanks are due to Sri E. V. Abraham, B.SC., Assistant Entomologist, Agricultural College and Research Institute, Coimbatore, and Mr. E. O. Pearson, M.A., Director, Commonwealth Institute of Entomology, London, for having identified the pest and parasites respectively. The generous help extended by Sri Kondaswamy Naidu, Superintendent, Sewage Farm, Madurai, in conducting the observations is also acknowledged. Our thanks are also due to Sri M. Basheer, B.SC. (Alig.), M.A. (Stan.), F.E.S.I., Government Entomologist and Associate Professor, Agricultural College, Coimbatore, for his valuable guidance in preparing this note.

AGRICULTURAL DEPARTMENT,
MADRAS,

B. VASANTHARAJ, B.SC. (Ag.)
K. R. NAGARAJAN, B.SC. (Ag.)

REFERENCES

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Perraju, A. *et al.* (1959): *Andhra Agri. Jour.* 6 (4): 190-1.

16. CORRECT NAME OF THE ASIATIC BUTTERFLY HITHERTO KNOWN AS *DANAUS* (OR *PAPILIO*) *PLEXIPPUS*

There has been prolonged controversy as to whether the American Monarch Butterfly or the Asiatic species known as the Common Tiger had prior claim to the name *Danaus plexippus* (Linnaeus). Both these species have passed under the same name for many years. Rev. E. M. Shull recently sent us a copy of the letter received by him from Dr. Charles L. Remington of the Department of Zoology, Yale University, in which the latter points out that, on the basis of full evidence, the International Commission on Zoological Nomenclature has ruled (Opinion No. 282 published 1 October 1954) that the name hitherto used for the Asiatic butterfly is in fact correctly applicable only to the North American insect while the Asiatic species should now stand as *Danaus genutia* (Cramer). Opinion 282 which gives this ruling is a lengthy document and would be of little interest to most readers, but the above summary of its conclusion deserves note for future guidance. Corbet & Pendlebury (1956, BUTTERFLIES OF THE MALAY PENINSULA: 141-142) have already followed this ruling and called the Asiatic species *Danaus genutia* (Cramer).

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
February 18, 1960.

EDITORS

17. OCCURRENCE OF THE BLUE MORMON (*PAPILIO POLYMNESTOR* CRAMER) IN BOMBAY

Having recently seen the Blue Mormon (*Papilio polymnestor*) in my garden on Pali Hill, I have searched old issues of the Society's journal for references to its occurrence in Bombay and its neighbourhood.

Writing at a time when Bombay had many more trees than it has now and a much smaller human population Aitken (1887) confessed that he was unable to understand the distribution of this butterfly. He observed: 'It is absolutely unknown in Bombay and I imagine throughout the Konkan, but becomes one of the most familiar objects as soon as we reach a level of 2000 feet. I do not think it occurs in the Deccan generally, but in Poona it frequents the old gardens in the city. Again it abounds all along the Malabar Coast at the level of the sea. Its chief season appears to be the latter half of the monsoon, but a good many come out in March and some may be met with all through the hot months.' Commenting on this Bentham (1889) stated that the butterfly was frequently seen at Dapoli, 70 miles distant from Bombay. Aitken himself seems to have changed his opinion about the non-occurrence of this butterfly in Bombay and wrote in 1903 (Aitken & Comber, 1903): 'occasionally found even in Bombay'. The next reference is by Best (Best, 1951, with notes by Alfrey): 'One seen on the 6th November near Tulsi. A very difficult butterfly to catch', on which Alfrey comments: 'I record having seen a fine female in the garden of "Silver End", Strand Road, obviously travelling from across the harbour'. In a supplementary note Best (1955) wrote: 'Two more seen on the path between Tulsi Lake and Kanheri Caves. This species must be very scarce on the island.'

In view of this last observation of Best and the fact that there is only one definite record of its occurrence in Bombay it may be of interest that I have seen this butterfly twice in the last two months:

18 February 1960. 12.25 p.m. Flew across my garden in a southerly direction at a height of about 15 feet above the ground. Steady unhurried flight. In good condition as far as I could see.

25 March 1960. 11.45 a.m. Flew across my garden in a northerly direction at a height of about 11 feet above the ground. Just before passing out of the garden turned back in its track for a distance of 20 to 25 feet, and then turned again and proceeded in its original direction. Steady unhurried pace. In good condition.

There is a further record from Mr. Basil W. Wirth, whose observations form the basis of a Miscellaneous Note at page 358 of Volume 56 of the *Journal*. In answer to an inquiry he very kindly sent me a note dated 24 February 1960 which deserves to be reproduced in full:

'First and foremost I must say that I have never seen *Papilio polymnestor* flying in any direction other than south—always north to south! They were observed in the following order:

September 1956. Three, all within two to three days of each other starting in the third week. All seen in 'Wadia House' garden (in Cuffe Parade Extension) and all slightly ragged.

25 September 1957. Colaba Road (near Pasta Lane). A perfect insect.

9 October 1957. One seen in 'Wadia House' garden.

16 October 1957. Two seen in 'Wadia House' garden. Both ragged.

26 October 1957. Seen at Tulsi Lake one single specimen hovering around, apparently not intending to go in any particular direction.

15 October 1958. One seen flying high over 'Wadia House' garden on Cuffe Parade side.

1959. None seen.

17 February 1960. Saw one at height of first floor in 'Wadia House' garden. A very ragged specimen.

Most of these were seen at heights between 20 and 30 feet from the ground. All were seen after 11 a.m. but before 3.30 p.m.'

It would appear from these observations that *P. polymnestor* is not as scarce in Bombay as was formerly thought.

Wynter-Blyth (1957) says that *Papilio polymnestor* is commonest in evergreen areas [see also Yates (1931, p. 1005) and Wynter-Blyth (1944, p. 537)], and is not much found in the plains or in areas of low rainfall. It is probable therefore that the butterflies observed were merely flying through, a conclusion supported by Mr. Alfrey's observation of the *P. polymnestor* flying across the harbour. The uniformity of direction noticed by Mr. Wirth and the annual appearance of these butterflies in September and October suggest the possibility of a local migration.

49, PALI HILL,
BANDRA, BOMBAY 50,
April 13, 1960.

D. E. REUBEN

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18. ADDITIONS TO THE BUTTERFLIES OF BOMBAY AND SALSETTE

Since 4th September 1959 a record is being maintained of the butterflies entering the Society's rooms at 91, Walkeshwar Road, Malabar Hill, which overlook Chowpati Bay and face south and east. Up to the middle of January 1960, the list extended to thirty different species including two which are an addition to the lists of the butterflies of Bombay and Salsette published in *J. Bombay nat. Hist. Soc.* **50**: 331-9, **53**: 282-4, **54**: 215-6, and **56**: 358-9. They are:

HESPERIIDAE

Baoris conjuncta (Herrick-Schaffer): The Conjoined Swift.

LYCAENIDAE

Nacaduba nora (Felder): The Common Lineblue.

Nacaduba nora is also reported by our correspondent, Mr. Basil W. Wirth of 21 Colaba Chambers, Bombay 5, along with two other

Lycaenid additions, all taken by him at Colaba on 12 October 1959, namely:

Nacaduba dubiosa (Semper): The Tailless Lineblue.

Nacaduba beröe (Felder): The Opaque 6-Lineblue.

Bombay Natural History Society,
91, Walkeshwar Road,
BOMBAY 6,
February 11, 1960.

EDITORS

19. THE SUBMERGED LEAVES OF *NYMPHAEA PUBESCENS* WILLD.

(*With one plate*)

Conard (1905) in his monograph on the genus *Nymphaea* has described the germinating tuber of *N. lotus* (L.) Willd. He states: '. . . about three submerged leaves are first formed, varying greatly in size according to the supply of nourishment.' A summary of the three leaves he describes could be given thus: first leaf—petiole 3.8 cm. long, a filiform midrib 1.3 cm. long with minute protuberances on either side at the base representing the lamina; second leaf—deltoid, with rounded angles and broad, shallow, rounded sinus; third leaf—broadly deltoid, with deeper sinus. In a diagram accompanying this description (fig. 74, p. 195) the lamina of the first and second submerged leaves of *N. devoniensis* Hort. are shown, but they resemble the second and third leaves of his description of the previous species; possibly Conard also meant these 2 leaves are the last and next to last submerged leaves of this plant. He does not mention the leaves of *N. pubescens*, but assumes that leaf development is the same for the whole of his 'Lotos group'.

d'Almeida and Mullan (1925) describe the sprouting of the tuber of *N. pubescens* in this way: 'The first leaves are linear or acicular; then come the lanceolate, hastate and sagittate types successively . . . . also: 'The sagittate leaf is succeeded by the cordate and finally by the mature, floating, orbicular leaf'. This description of the first submerged leaves of this species is accompanied by a diagram (fig. 30, p. 68) of a sprouting tuber (d'Almeida gives the exact size of the tuber and its leaves in a later paper, see below). These authors also offer a diagram of a seedling of the same species (fig. 35, p. 76) showing a rosette of 12 apparently submerged leaves, but the exact size of the leaves is not given.

d'Almeida (1926) describes the 'tubers' of this species, which form after November and December as the dry season approaches. They are usually 6 cm. long and 3.5 cm. in diam., but they get smaller on drying; also, they are 'only the upper part of the rhizome', and the only leaves present are the scales which are left after the preceding leaves have become reduced in size and form. Sprouting of these 'tubers' takes place at the beginning of the rainy season.

McCann (1935), in contrast, describes the 'tubers' for the same species as ovoid and roundish and about 1-4 cm. long on short or long stolons. These 'tubers' are produced by the rhizome amid the roots of young plants.

It is apparent that the mature form and size of the submerged leaves of *N. pubescens* have received some attention, but information is still lacking on the exact size and form of these leaves, particularly those preceding the first formed floating leaves. In an attempt to supply some of this information, young plants of *N. pubescens* were collected from the village tank at Khandala. In this tank regeneration of this species (locally called 'kamal') takes place in the shallow areas where the small, spherical 'tubers' (*c.* 1 cm. in diam. with a piece of stolon attached, cf. authors mentioned above) and their young delicate leaves are protected by the matted layers of grass, which occur in these areas. Most of the young plants collected had between 2 and 4 submerged leaves and between 2 and 3 floating leaves.

Three typical plants were selected and the last 2 submerged leaves and the first 2 floating leaves were recorded to show the exact size and form (A, B and C of Plate and Table). These submerged leaves

TABLE

Petiole length (in cm.) of some leaves of *N. pubescens*

	Submerged leaves		*Floating leaves*	
	1	2	3	4
Plant A ..	14.5	10.0	22.0	22.0
Plant B ..	9.5	6.0	9.0	18.5
Plant C ..	12.5	12.5	24.0	18.7

are similar to some depicted in the sketch of the seedling by d'Almeida and Mullan (see above). Another young plant was selected and 4 of its 5 submerged leaves (laminae only) are shown here (D 1-4 of Plate) simply to show some of the subtle changes in leaf form. This particular plant had no floating leaves, as yet, and the youngest submerged leaf, though not shown, was similar to B2 although it was much smaller.

Some variation exists here even among the 3 plants (A, B, and C) growing under the same environmental conditions, still it is evident that the mature form is quite stable for the last 2 submerged leaves and also for the first 2 floating leaves of this species. In any case, these submerged leaves are much larger than any reported by Conard (1905) for any species in or out of the 'Lotos group'. The only submerged leaf recorded by him which approaches the size of the largest leaf depicted here is a leaf of *N. tuberosa* Paine (not in the 'Lotos group'), which is the third submerged leaf from one tuber (fig. 71, p. 190) and represents either the last or the next to last submerged leaf of this tuber. The lamina measures at its maximum length 6.5 cm. and at its maximum width 5.0 cm., in contrast to my A1 (next to last submerged leaf) the lamina of which measures at its maximum length its maximum width 5.0 cm., in contrast to my A1 next to last submerged leaf) which measures at its maximum length 9.0 cm. and at its maximum width 5.5 cm.

Only 2 examples of the stipules (found in pairs at the base of each leaf) are recorded in the Plate, since they vary little from leaf to leaf.

It may not be simply a coincidence that the largest submerged leaves reported so far for any *Nymphaea* species are found on two tuber-producing plants, but some points about the exact mode of tuber production in *N. pubescens*, as indicated, are in doubt.

ST. XAVIER'S COLLEGE,
BOMBAY, J. J. GAUDET
February 1, 1960.

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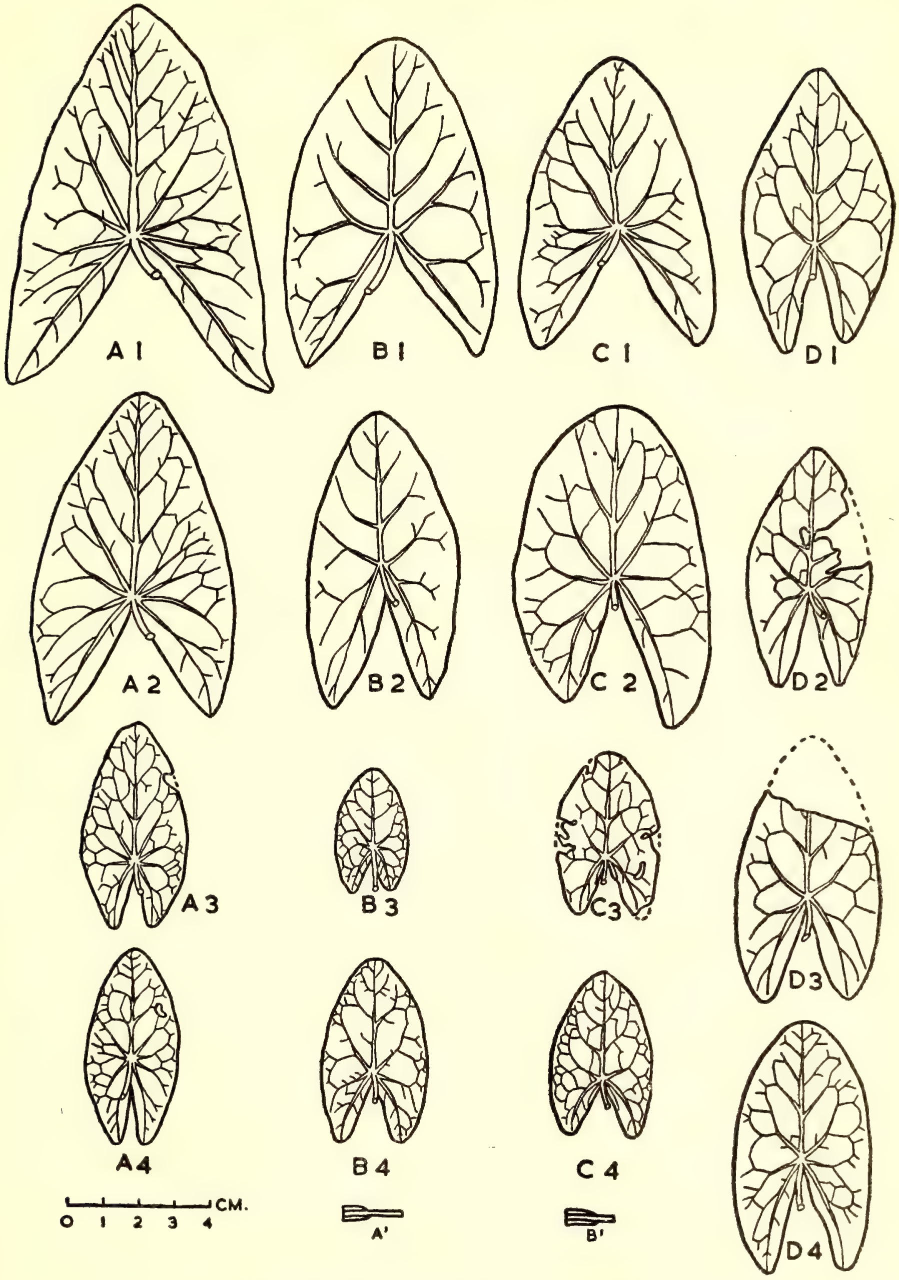
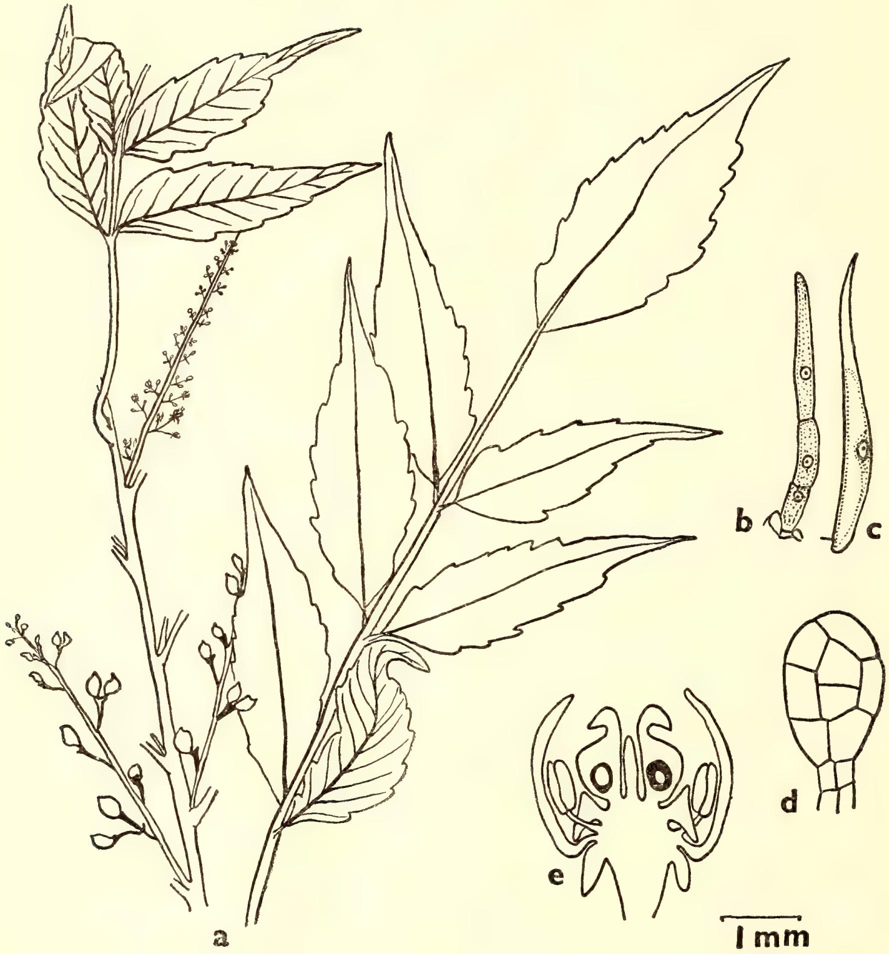

A1
B1
C1
D1
A2
B2
C2
D2
A3
B3
C3
D3
A4
B4
C4
D4
CM.
0 1 2 3 4
A'
B'

Leaves of *Nymphaea pubescens* Willd.

A1-4, B1-4, C1-4 Laminae from 3 different plants (1 & 2 Laminae of last 2 submerged leaves, 3 & 4 Laminae of first 2 floating leaves); D1-4 Laminae of the submerged leaves of a single plant; A' Stipules of leaf B2; B' Stipules of leaf B3.



Brucea amarissima (Lour.) Merr.

a. Branch with inflorescence; b, c, d. Multicellular, unicellular, and glandular hairs; e. L. S. of flower.

20. *BRUCEA AMARISSIMA* (LOUR.) MERR.—A NEW RECORD FOR SOUTH INDIA

(*With one plate*)

Brucea is a pantropical genus of the family Simaroubaceae with about six species, of which two, *B. amarissima* and *B. mollis*, are reported from various parts of India; they are said to be common in Assam, Tennaserim, Andaman Islands, Singapore, Borneo, Sumatra, Java, Philippine Islands, S. China, and Australia.

While on holiday in my native Perunnai, Changanacherri, Kerala State, during the summer vacation of 1952, I observed a plant of *Brucea amarissima* in flower in waste lands near the town club. Subsequently I came across several plants in other places. These plants were said to be wild or spontaneous, not cultivated. The bark and seeds of the species are used in medicine, particularly in the treatment of dysentery; for this reason the plant is well known in those parts of Kerala. On the other hand none of the floras of south India consulted mentioned the plant for the area. Cameron (1894), Rama Rao (1914), Gamble (1915), Fyson (1915, 1932), Bourdillon (1937) have been studied; none of them has reported the genus *Brucea* for south India.

This absence of data on the plant prompted me to make an intense search in various parts of Kerala; this note is based on my observations of the last seven years. I have found the plant growing wild in a number of localities, such as Changanacherri, Thiruvalla, Kanjirapally, Kottayam, etc., in hilly areas; it may be found in other places. The plant does not seem to grow in the coastal areas; my specimens have been examined or collected from the hills.

Brucea amarissima is a small tree, 5-8 m. high. Leaves alternate, imparipinnately compound, 30-45 cm. long; leaflets 7-13, lanceolate, acuminate, serrate, 7-9×2-2.3 cm., the terminal one usually larger; veins 10-12, more prominent and covered with yellow pubescence on the lower surface. Inflorescence axillary, paniculate, of variable length (7.5-35 cm.), densely yellow-pubescent. Flowers bisexual, minute, in alternate distant cymes; pedicels 4-5 mm. long, thickened in fruit, pubescent with unicellular, multicellular, or glandular hairs. Calyx 4-partite, minute, 0.5-0.7 mm. long, valvate (I have not been able to confirm Hooker's statement that the sepals are imbricate), rarely persisting in fruit. Corolla 4-partite, valvate, spathulate, 1.5-2 mm. long. Stamens 4, shorter than and alternating with the petals, inserted beneath a very prominent disc. The lower portion of the disc is four-lobed, the lobes opposite the petals, the upper portion is cup-like and four-celled, each cell enclosing a carpel. Gynecium of four free carpels; style very short, stigma reflexed. Drupes fleshy, purplish black, ovoid, one-seeded; generally out of the four carpels, only one or at most two develop into fruit. Seeds smooth, slightly albuminous; seed coat thin, membranous. Embryo of two cotyledons, which are fleshy. The floral axis continues above the level of the carpels.

Flowers and Fruits: May-August.

The fruits are eaten by birds, and the latter thus help in the distribution of the species.

I am grateful to Messrs. O. J. Kuruvilla and M. D. Joseph of St. Berckman's College, Changanacherri, for the help rendered in the preparation of this note.

BIRLA COLLEGE,
PILANI,
October 15, 1959.

N. C. NAIR

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21. THE IDENTITY OF THE *ENTADA* PLANTS FROM BOMBAY

Th. Cooke, in his FLORA OF THE PRESIDENCY OF BOMBAY **1**: 437, 1903, has listed a plant under the name *Entada scandens* Benth., locally known in various parts of Bombay under the name of *Garbi* in Marathi. The nomenclature and synonymy of the plant is more than ordinarily complicated. In my 'Flora of Khandala on the Western Ghats of India (in *Rec. Bot. Surv.* **16** (1): 94, 1953, I listed the plant under the name *Entada phaseoloides* (Linn.) Merrill. A recent paper by J. P. M. Brenan in *Kew Bulletin* (1955: 161 et seq.) has caused me to re-examine all the sheets of the genus in Blatter Herbarium, after which revision I came to the conclusion that all the specimens from Khandala and other parts of the W. Ghats should be called *Entada pursaetha* DC.

To check this conclusion I had several specimens sent to the Royal Botanic Garden, Kew, for examination by Mr. Brenan. The results of this second examination were communicated to me by Mr. Brenan in a private letter, in which among other things, he writes: 'The specimens of *Entada* which you mentioned in your letter of the 6th March have arrived safely. I have now examined them and, as I think we both expected, there seems no evidence at all against all of them being *Entada pursaetha* DC.'

To help other Bombay botanists in the identification of their specimens this note is being written.

Entada scandens Benth. was based on *Mimosa scandens* Linn. (1763), which as Johnston has shown in Sargentia (1949) was an aggregate species, of which the most typical plant was that mentioned by Rumphius in Herb. Amboin. **5**: 5-8, t. 4, 1750, under the name of *Faba marina*. The correct name for this plant is *Entada phaseoloides* (Linn.) Merrill, 1914, based on *Lens phaseoloides* Linn., 1754. *Mimosa scandens* Roxb. Fl. Ind. **2**: 554, 1832, from Sylhet seems to be a different plant from *M. scandens* Linn., but its identity is not yet clear.

Entada pursaetha DC. is given in the literature as being a plant from Africa; however, Alston has listed it as the name of the species to be found in Ceylon; it is also the name of our plant in Bombay State. The nomenclature of these two plants is the following:

(*a*) **Entada phaseoloides** (Linn.) Merr. in Philipp. Journ. Sci. **9**: 86, 1914; Brenan in Kew Bull. 1955: 164; (non Santapau, 1953). *Lens phaseoloides* Linn. Herb. Amboin. 18, 1754. *Mimosa scandens* Linn. Sp. Pl., ed. 2, 1501, 1763. *Entada scandens* (Linn.) Benth. in Hook. Journ. Bot. **4**: 332, 1841 (non Baker in Hook. f. Fl. Brit. Ind. **1**: 287, nec Cooke).

The real *E. phaseoloides* Merr. comes from Amboina in the Moluccas, and does not extend to India. *E. scandens* Benth. is identical with *phaseoloides*, and does not extend to India, in spite of the fact that the name has been used in most of our provincial floras. This plant has 1-2, occasionally up to 3, pairs of leaflets; the pod is straight or curved but not twisted; the inner layer of the pod has the consistency of tough parchment.

(*b*) **Entada pursaetha** DC. Prodr. 2: 425, 1825 (excl. syn. nonnullis) & Mem. Leg. 421, 1826; Brenan in Kew Bull. 1955: 164. *Mimosa entada* Linn. Sp. Pl. 518, 1753. *Entada rheedii* Spreng. Syst. **2**: 325, 1825. *E. monostachya* DC. Prodr. 2: 425, 1825. *E. scandens* Cooke, Fl. Pres. Bombay **1**: 437, 1903, (non Benth. 1841).

Three of these names, viz. *pursaetha*, *rheedii*, and *monostachya*, all date from 1825, and there is no evidence to show that *rheedii* is prior to the others; for this reason Brenan has selected *E. pursaetha* DC. which in addition 'can be well typified and which has been adopted as the name of the common Ceylon plant by Alston, Fl. Ceylon, 6, 95 (1931) . . . The distribution of *E. pursaetha* is very wide, from West and East Africa eastwards to China, Guam, New Guinea and northern Australia.' (Brenan, loc. cit. 164.)

This plant is described as having 3-4, occasionally up to 5, pairs of leaflets; the pods are straight or curved but not twisted; the inner layer of the pod is thick, rigid, woody; the axis of the inflorescence is subglabrous to somewhat pubescent; the calyx is glabrous.

The identity of the Assam-Nepal plant remains doubtful; Brenan states *in litt.*: 'it may be an extreme variant of *E. pursaetha* itself, but it would be unwise to come to a final verdict without more evidence.'

From the foregoing notes, it is clear that the plant which is common in Khandala and other parts of the Western Ghats is not *Entada scandens* Benth. nor *E. phaseoloides* Merr., but it is *Entada pursaetha* DC. It is now too late for me to take up this name for the 2nd edition of my *Flora of Khandala*, which is expected to be out in the near future; this is why this correction is published in this *Journal*.

It is with a deep sense of gratitude that I wish to acknowledge the help received from Messrs. C. E. Hubbard and J. P. M. Brenan of the Royal Botanic Gardens, Kew, in the identification of my specimens of *Entada* from Bombay.

ST. XAVIER'S COLLEGE,
BOMBAY 1, H. SANTAPAU, S.J., F.I.N.
November 24, 1959.

22. THE MAIN BOTANICAL GARDENS OF THE U.S.S.R.

(*With a photo*)

Moscow acquired a new and important scientific centre and at the same time a splendid place where people can rest when the main botanical gardens of the U.S.S.R. Academy of Sciences were opened. They occupy 360 hectares[1] of land in a picturesque suburb of the capital, in the natural conditions typical for the central zone of the

---

[1] One hectare = 2·471 acres.—EDS.

U.S.S.R. Two-thirds of the territory are woodland: oak forest, birch grove, pine wood, and mixed forest. Most of the trees are in their prime, being from 70 to 80 years old, some of the oaks are 200 years old.

Victoria cruziana in the Botanical Garden, Moscow.

The staff of the botanical gardens are doing important research work and solving many problems of plant acclimatization. Scientists select the most promising wild plants for cultivation and breed new varieties useful to the national economy or suitable for planting in cities, villages, and health resorts.

Special care is devoted to the development of I. Michurin's theories. The great scientist's work in distant hybridization is continued with successful results, both theoretical and practical. Crossing cultivated plants with wild varieties has produced hybrids with greater biological resistance and higher yields.

The scientists who work in the gardens also conduct research in biochemistry, the use of stimulants of plant growth, and other subjects.

The new botanical gardens are rapidly becoming popular with Muscovites. Many visitors to the capital also come here, for the gardens are included in the plan of excursions for tourists from all parts of the Soviet Union and foreign countries. The big collection of plants from different parts of the U.S.S.R. and many other countries is of great interest. It includes about 400,000 specimens of 11,000 different plants—a really tremendous collection.

The exposition of U.S.S.R. flora occupies 25 hectares, showing about 3000 plant species, or more than one-tenth of the plants growing in the U.S.S.R. and the most typical at that. Visitors to this section can see plants from the Carpathians, the Ukrainian steppes, the Crimea, the Caucasus, central Asia, Siberia and the Far East. The Far Eastern flora is represented by 800 different plants, including the Amur cork oak, the white walnut tree whose wood is used for veneer, and the Korean cedar. Lianas hang from the branches of trees and enormous ferns grow at their foot. Grass varieties are very numerous, especially those that come from Sakhalin, including angelica, wild rye, and many other species.

A garden where flowers bloom from the beginning of May until late autumn grows at the edge of the oak wood. The first to blossom are lilies-of-the-valley, growing among the roots of the oaks. They are followed by narcissus, tulips, lilac, and peonies. Phlox of the most varied colours are now in bloom and dahlias are beginning to open up—autumn is approaching.

The botanical gardens have the biggest collection in the U.S.S.R. of trees and shrubs growing in open ground. They come from different parts of the world. Nine hundred species are distributed according to systematic features and are supposed to form one-third of the trees and shrubs that can grow in the conditions of the Moscow district.

In the section of cultivated plants visitors can observe plant evolution and see how, under man's influence, plants were transformed from wild species to the modern varieties of vegetables, fruit, and industrial plants. Varieties bred by Michurin and his numerous followers can be seen here.

The huge glass building standing in one of the glades is a conservatory housing a big collection of tropical and subtropical plants. There are more than 10,000 specimens of plants from evergreen forests, warm lakes and rivers, savannas and deserts. A temperature and humidity similar to those of the natural environment of the plants collected in the conservatory are maintained in every section.

The rich collections of the main botanical gardens of the U.S.S.R. are open for everybody to see.

c/o U.S.S.R. Embassy in India,
New Delhi.
B. KOTELNIKOV

23. THE WATER HYACINTH—AN APPEAL FOR INFORMATION

May I enlist your help in the following matter? When I settled down in West Bengal in 1957, I noted that the flowers of *Eichhornia crassipes*, the water hyacinth, had one set of stamens longer than the style, another set shorter. This suggested that the flowers are trimorphically heterostylic, like those of *Lythrum salicaria*. That is to say, we would expect also to find long-styled flowers, in which there were two sets of stamens shorter than the style, and short-styled flowers, in which there were two sets of stamens longer than the style, as well as the common mid-styled form.

I found a long-styled plant in a swamp near Madras, and my colleague Shri S. K. Roy has found another in a tank at Bangalore, but the condition is clearly rare in India and is not represented in herbaria which we have seen.

On the other hand the long-styled form is quite common both in Singapore and on the mainland of Malaya, as Shri Roy observed in 1958.

I suggest that readers of the *Journal* might care to report to the Bombay Natural History Society on the form of this plant in their neighbourhood, the reports to be collated by the Society when enough accumulate. I should personally be glad to hear of long-styled or short-styled flowers, since it may be possible to investigate their genetics.

Indian Statistical Institute,
Barrackpore Trunk Road,
Calcutta,
January 9, 1960.

J. B. S. HALDANE

Gleanings

HYDEL WATER AND PLANT LIFE

Speaking of the Owen Falls Hydro-Electric Scheme in East Uganda, Richard St. Barbe Baker (1954) says in SAHARA CHALLENGE [Lutterworth Press, London]: 'As an ecologist I could not share this enthusiasm. In what they are doing I saw certain disaster. Water that comes through a turbine is physically different from when it went in. In the process, electro-magnetic force, which keeps the trace elements in motion in each molecule or electron, is given off, with the result that those essential elements drop out; the water goes on its way deprived of them and they are needed to promote fertility and the growth of wholesome food. Also the vitality of the water is beaten out of it and it becomes flat and sick and affects the whole course of the river or valley through which it passes. I have witnessed this phenomenon for myself in the U.S.A. where the much-vaunted Tennessee Valley Project has reduced the stamina of vegetation, exposing plant life to pests, nature's method of eliminating sick plants and animals.'

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—6-7-1960. C3575
EDITORS: SÁLIM ALI, AND H. SANTAPAU
91 WALKESHWAR ROAD, BOMBAY 6

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Journal of the Bombay Natural History Society

506.54
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Vol. 57, No. 2

Editors
H. SANTAPAU, S.J., & HUMAYUN ABDULALI

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1960 AUGUST Vol. 57 No. 2

The Breeding of the Grey or Spottedbilled Pelican, *Pelecanus philippensis* Gmelin

BY

E. P. GEE, M.A., C.M.Z.S.

(*With four plates*)

Where do pelicans breed in India? This is a question often asked, but an answer never seems to be forthcoming. I have been asking forest officers, sportsmen, and others in north-east India for many years now, but no pelicanry seems to exist in these parts.

Pelicans are quite common in this sub-continent, especially the Grey or Spottedbilled Pelican (*Pelecanus philippensis* Gmelin), and I have often seen them on the Brahmaputra and on *jheels* in Assam. I remember seeing several hundreds on a *jheel* in Kaziranga in December 1950, and there are usually a few dozen to be found in that sanctuary. On the Manas and Beki rivers in north-west Assam there always used to be about a hundred birds near the Bhutan border, though as a matter of fact this cold weather only three were to be seen.

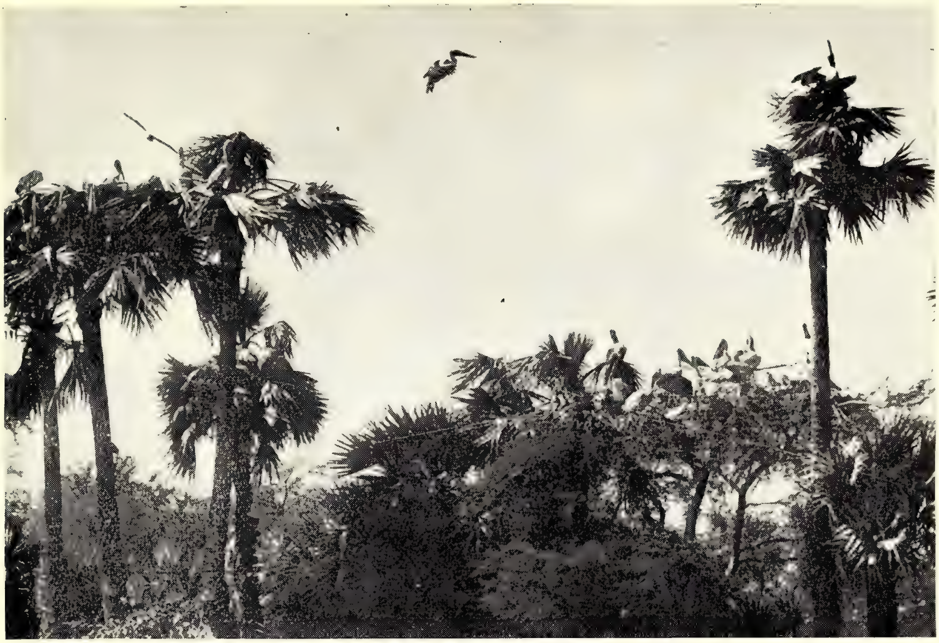
It is an extraordinary fact that such a large and spectacular bird as the pelican, justly famed for being able to hold more in its beak than its belly can, should not be better known. In the last century Blanford deplored that of late years no authentic account of pelicans breeding in India had appeared, though Jerdon (writing in 1864) said he had visited a pelicanry in the Carnatic 'where the Pelicans have (for ages I was told) built their rude nests, on rather low trees in the midst of a village, and seemed to care little for the close and constant proximity of human beings'.

Whistler stated in 1928 that there was no known breeding haunt of the pelican in India. In Stuart Baker's book (1929) he mentions that 'there was formerly a breeding place in Sylhet, possibly still existing, where they did not begin to lay until July, when the floods had commenced to rise'; and it would be interesting to know if this pelicanry still exists in present-day East Pakistan.

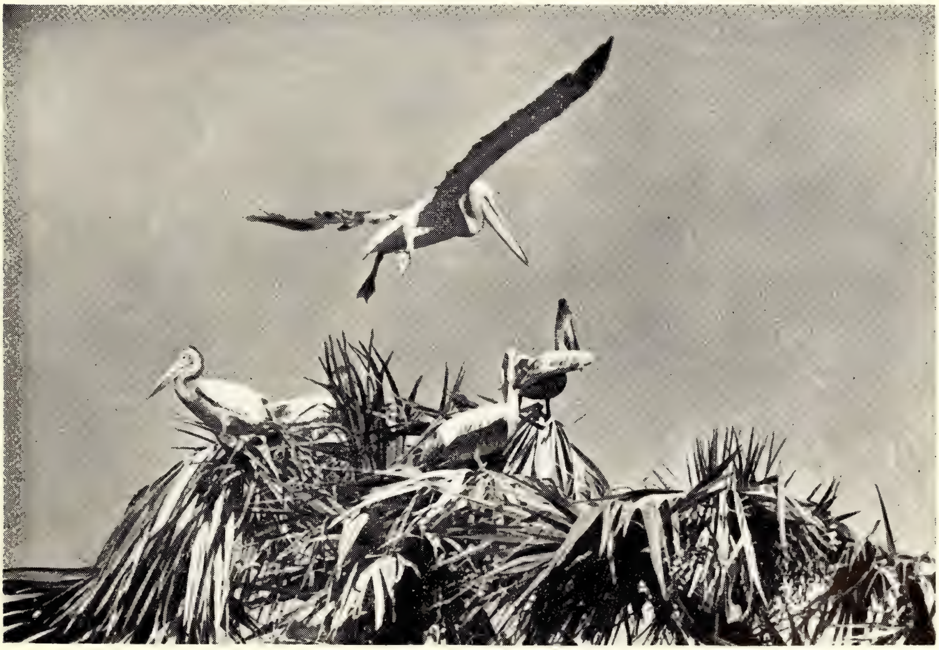
Delving into the back numbers of the *Journal of the Bombay Natural History Society,* I find (in Vol. 14, page 401) that at the end of March 1890 a person named W. Howard Campbell found a large number of Grey Pelicans breeding in company with Painted Storks in a secluded valley in the extreme east of the Cuddapah District, in what is now Andhra State: 'The nests, of which there were several hundreds, were on neem and tamarind trees in a small village called Buchupalle. The people of the village were very much averse to any interference with the nests. The birds trusted them and they would not have them injured, they said.' It is not known if this small pelicanry still exists.

In June 1906 (in Vol. 17, page 806) C. E. Rhenius found a small pelicanry in the village of Kundakolam in the extreme south of Tinnevelly District, in Madras State. About twelve tamarind trees contained nests with fully-fledged young birds. There were also Painted Storks nesting there—the Pond Herons, Cattle Egrets, and Night Herons had left: 'The villagers looked on these birds as semi-sacred and would not allow anyone to disturb or molest them, so that they return to build there year after year, and have done so for years past.' In April 1944 (in Vol. 45, page 426) this very pelicanry was visited by C. G. Webb-Peploe, who saw only ten nests of pelicans with young birds in them (and also 200 nests of Painted Stork and many of Night Heron and Little Egret). The headman of the village protected them, he said, and the birds seemed to have been nesting there for 60-70 years at least. There is no further news of this diminutive colony of pelicans.

From all accounts pelicans breed in Ceylon in February and March; but the largest pelicanry in this part of Asia, if not in the whole world, is or was near Shwe-gyen on the Sittang River in Burma. This huge pelicanry, described as being some twenty miles long by five miles broad and as containing 'millions' of pelicans and Adjutant Storks, was discoverd by Oates in 1877. The nests contained eggs in November. Stuart Baker in 1929 reported that they still bred there in their hundreds of thousands in company with Adjutants. The area was again visited by Wickham in 1910 who found that 'countless millions of birds still bred over a vast area'. According

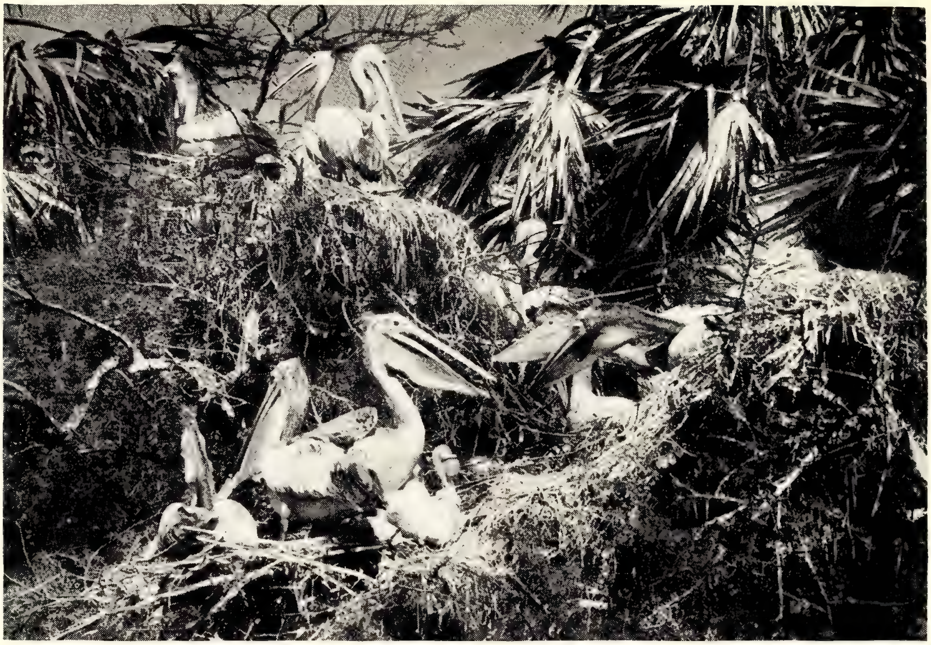


General view of part of pelicanry showing nests in palmyra and babool trees

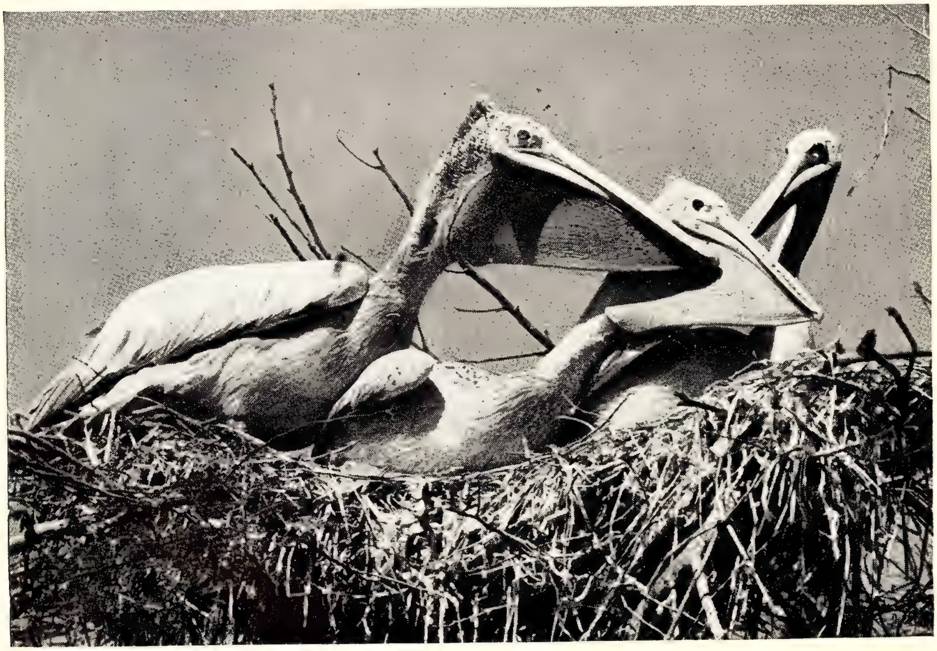


Nesting activity on palmyra trees

Photos: E. P. Gee



Nesting activity where babool and palmyra trees intermingle, showing adults [illegible] and very young chicks



Three incubating adults. Each nest contained two eggs. When excited, the birds extend their pouches.

Photos : E. P. Gee

to B. E. Smythies the birds were still there in 1935, but in 1946 'the immense colonies which Oates found on the Sittang have disappeared'. No recent news of this pelicanry has been received.

Now to return to India. In 1946 (Vol. 48, pages 656-666) K. K. Neelakantan of Trivandrum commendably discovered a pelicanry of considerable size near the Kollair Lake in West Godavari District of what is now Andhra State. It was close to the village of Aredu, and is reached by train on the main line from Calcutta or Madras, the station Tadepallegudem being 15 miles away. This same person made an official visit to the pelicanry in December 1959 on behalf of the Andhra Government, and was kind enough to supply me with all the latest information about the place, where to stay and so on.

Accordingly I visited the pelicanry in January of this year (1960), and found a remarkable sight. Probably not less than 3000 pelicans were nesting in an area of about two square miles of well-irrigated paddy fields. The nests were mainly in palmyra trees, and sometimes in babool or rain trees or coconut palms, which are planted along the irrigation bunds. Sometimes there were as many as twelve to fifteen nests in one tree, and often not far up from the ground. The villagers protect them as much as they can—partly because of the trust the visiting birds place in them, and partly because of the value of the guano or droppings as a fertilizer for the crops.

The birds this year have shifted their breeding ground from Aredu. There is a small colony of about 25 nests near Ganapavram, but the large colony of about 1500 nests is near Kolamuru village, about three miles from Aredu. When I was there from January 13th to 19th the small pelicanry contained half-grown young birds, while the nests of the larger one had eggs or else very young chicks. It was thus possible to see the breeding of this bird in all its stages.

I went there primarily for photography, both ciné and still, but managed to find some time for observation of the habits of these extraordinary birds. Although the pelican is a large and somewhat ungainly-looking creature, once it has managed to become airborne after much effort and flapping it flies very gracefully. With undercarriage of legs and webbed feet up, head well back on the shoulders, and large bill resting on the front of the neck it sails through the air with apparently little effort.

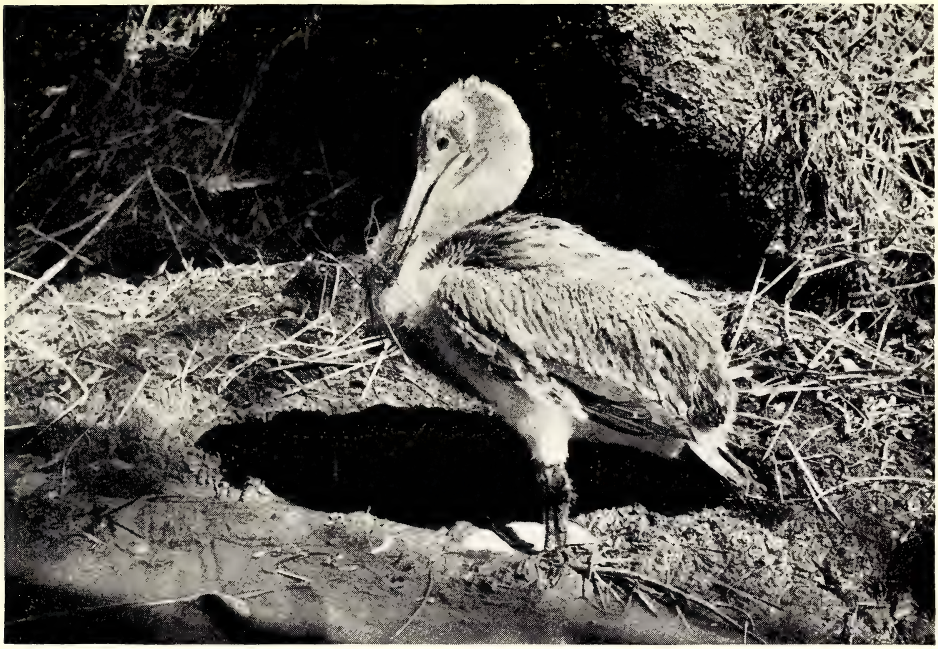
I thought at the time that I had stumbled on something new about the soaring of pelicans which is done regularly over the nesting area. Every day I saw this 'community soaring' going on, usually about 50-150 birds wheeling round and round on the thermal currents in the same way as vultures do. They (probably the mates of the brooding birds) would fly from their nests and join the soaring at the lowest level, and soon attain a great height, eventually becoming tiny specks in the sky. I observed, however, on two days at about 2.30 to 3:30 p.m. that some pelicans left the 'community soaring' and went in for 'individual soaring' at a great height, wheeling round and round on their own. And then suddenly a bird would start to do aerobatics —twisting, turning, and rolling in a most peculiar and comical way. Out of sheer *joi de vivre*, I presume.

Most people know that the upper mandible of the pelican is long, slightly boat-shaped, and ends in a nail or hook. The lower mandible consists of two flexible arches which support a large elastic pouch. This pendant and distensible pouch of naked membrane forms an ideal landing net when the birds are fishing. I noticed that whenever the birds became excited in any way, the pouch was extended giving the beak a thick triangular appearance.

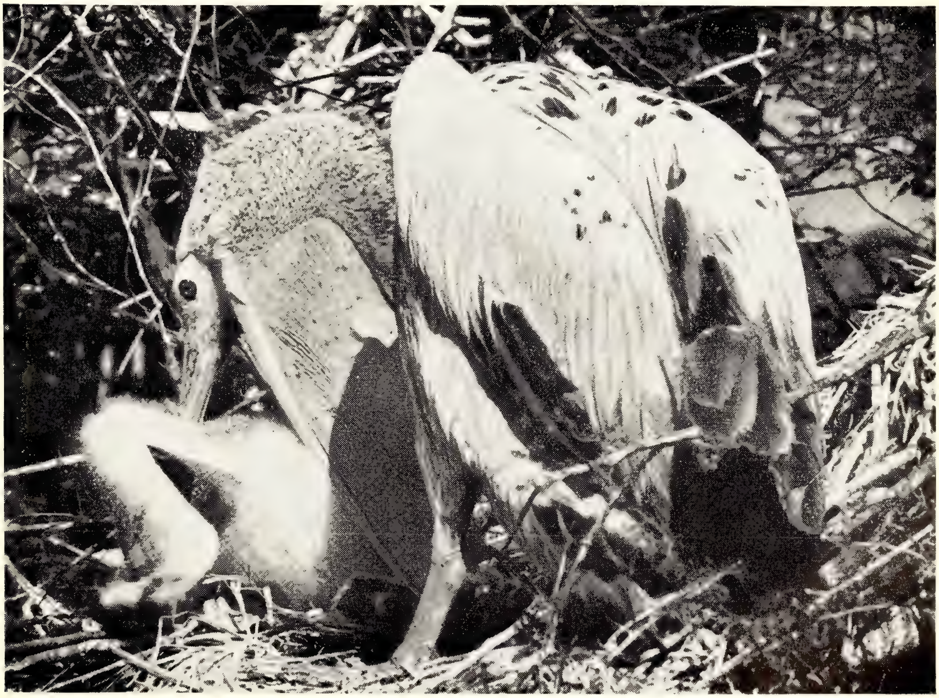
Many people must have seen pelicans fishing: like cormorants they do it together in a party, forming a line or semi-circle and driving the fish into the shallows where they scoop them up in their pouches. Talking about fish—how do pelicans choose a nesting site? How do pelicanries come into existence, to which pelicans will come from all parts of India and from which, after the breeding season is over, they will return to their respective haunts in all parts of India? The answer presumably is—fish supply. They must have a place where they can catch sufficient fish to feed themselves and their growing offspring. The amount of fish required to feed so many pelicans must be very large indeed, amounting to several tons per day.

From a cloth 'hide' fixed in a tree just above the level of some of the nests, I was able to observe and photograph the intimate family life of the pelicans in their home. The enjoyment derived from being only a few feet away from wild birds while they have not the faintest idea that you are there has to be experienced to be believed. After a short absence due to the alarm caused by your climbing into the 'hide', the huge birds return to their nests in twos and threes, wings outstretched and undercarriage of legs and webbed feet forward. Then the inevitable shuffling and bickering of birds breeding in a community. Then those with eggs settle down to brood, while those with chicks start to feed them.

The eggs are a dirty white, and the chicks are born naked. Soon a snow-white down covers their bodies, and this is gradually replaced by sprouting feathers of a brownish grey. The bills of the young

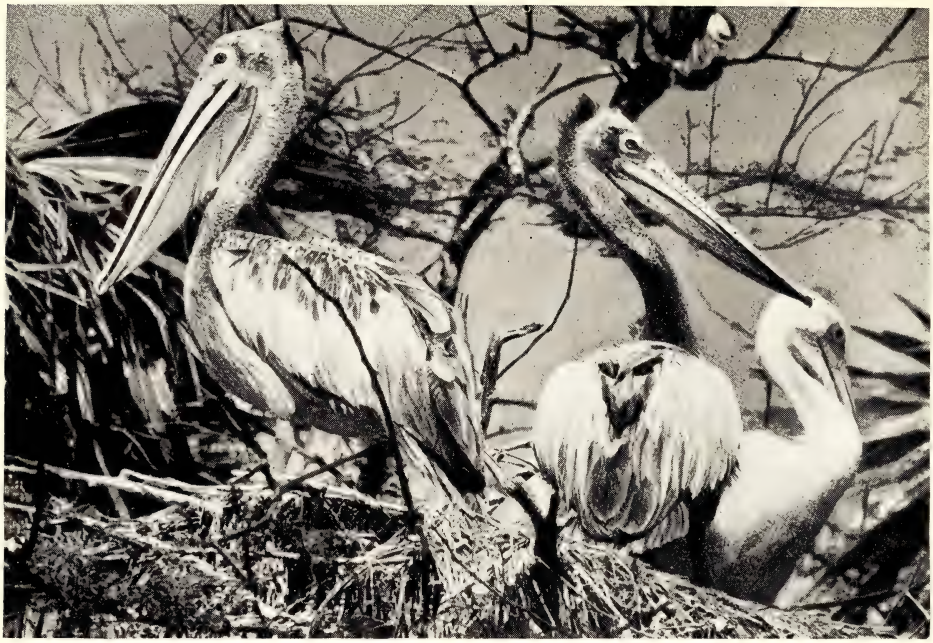


One of the unfortunate youngsters which had fallen from its nest. It was strutting up and down the ground below picking up what it could

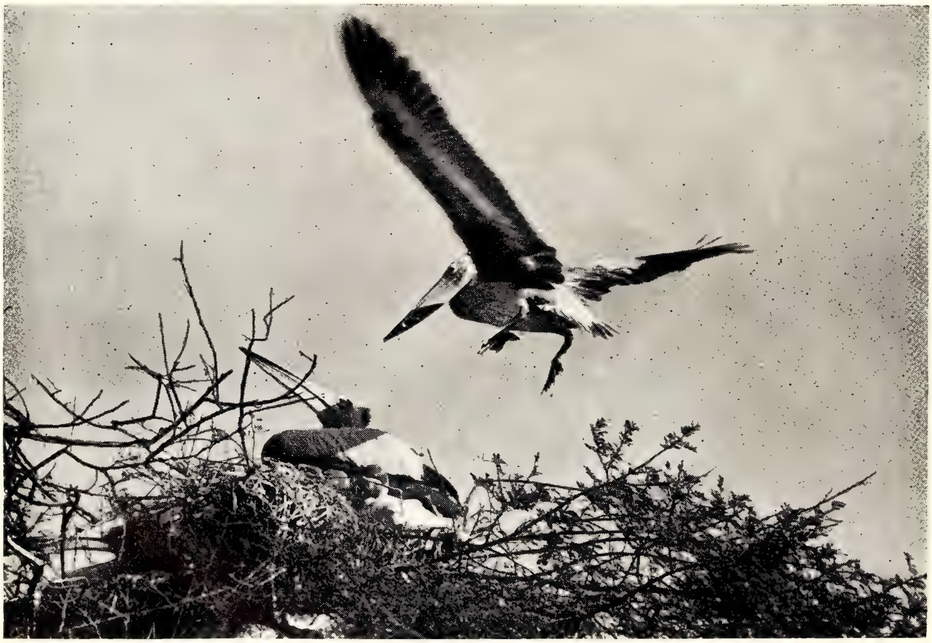


Parent feeding very young chick, which is mostly inside the capacious pouch. The bulge where the bill of the chick is pressed against the membrane of the pouch can be plainly seen

Photos : E. P. Gee



A close-up of nests showing young bird about 2 to 3 weeks old at right



A nest with parents and young on top of a babool

Photos : E. P. Gee

birds are smallish—but the hooked nail and the pouch are there. The bills develop very quickly.

The pelican is renowned for being extremely devoted to its young. In heraldic and ecclesiastical symbols in England it used to be represented as standing above its nest with its wings outstretched and nourishing its young with its blood. It used to be described as 'a pelican in its piety' (piety here having the classical meaning of filial devotion). This legend that pelicans feed their young with their blood probably arose from the fact that these birds, like cormorants and darters, feed their young by regurgitating partly digested fish into the tops of their pouches for the young to feed on.

Almost spellbound I watched how a parent bird with wonderful tenderness and care nudges a youngster with the tip of its bill, and then the chick stands up and thrusts its bill and neck far into the parent's pouch. In the case of a young chick the whole of the youngster disappeared into the pouch, making the proverbial sword-swallower's act seem nothing at all. After one chick has had enough, and the parent seems to be the sole judge of this, another chick is gently nudged into feeding activity. If a previously fed chick tries to get a second helping, it is carefully pushed aside by the fair-minded parent—though I did see sometimes that two or three small chicks all got into the parent's capacious pouch at once!

In most trees the nests were contiguous, often looking like strings of large beads. And the chicks, two or three in a nest, often got mixed up with those of other nests. Once, while the parent birds were away due to my arrival at the tree, I got a boy to climb up and sort out the chicks by their age groups, putting the tiny naked ones together where they belonged and the larger ones in their nests and so on. But in no time at all they began to stagger about like drunks and got mixed up again. When the parent birds returned, I think they managed to identify their own babies before feeding commenced. One poor adult pelican seemed to have been unlucky in love, with no mate or nest of its own, and always got pecked by its neighbours before sitting down at the end of the branch on nothing at all . . .

Sometimes a chick lurches too far, and over it goes—down to the ground. When this happens, the chick is completely ignored by the otherwise devoted and 'pious' parents, which seem not to notice it and make no effort to help or feed it. If it is a young chick it is bound to perish either from starvation or from attack by a predator. If it is a larger chick it struts up and down below the nests, picking up what fish it can; and such a bird has a chance of surviving.

There were a few crows about, scavenging on what they could find and possibly stealing eggs at times. The number of Brahminy Kites was very great—these were living apparently on fish dropped or vomited by the pelicans or spilt from feeding at the nests. Pariah Kites were few in number. Both species of kites joined in the 'community soaring' of the pelicans.

The attitude of the local villagers to the pelicans was interesting. Some of them said to me, through an interpreter, that it was wrong to shoot or harm the pelicans which were visitors, coming every November. They brought good health to their villages, said some of them, and their excreta provided a good fertilizer for their fields. Others said they did not disturb or harm the pelicans, as these birds did no harm to them. One villager suspiciously thought that I was taking the blood out of the pelicans, but when it was explained to him that I was doing just the opposite he seemed to understand.

I was informed that small gangs of 'low-caste men' sometimes came from Bhimavaram at night, and speared roosting pelicans with long bamboo spears for selling to hotels. About a hundred birds, I was told, had been killed this season so far (mid-January). It is to be hoped that the State Government of Andhra will take appropriate steps to prevent this sort of thing, by declaring the pelican a protected species (at least during the breeding season), or else by constituting the pelicanry as a sanctuary or protected area.

Now for noises made by pelicans. When Oates visited the huge pelicanry in Burma in 1877 he commented on the silence of the place. His actual words were: 'Notwithstanding the millions of birds which breed in this forest, a most wonderful silence prevails. The pelican seems to be perfectly mute, and the adjutants only bellow at intervals. The only sound which is constantly heard, and after a time even this sound passes unnoticed, is a sort of Aeolian harp caused by the movement of the wings of innumerable birds high in the air.'

But in the Andhra colony the noise of the nesting pelicans could be plainly heard a quarter of a mile away. And when standing near the trees containing nests the noise was really loud: there were the long-drawn moanings, harsh throaty gruntings, and sharp yap-yaps like the yelping of a dog. Also every now and then a bird would open wide its bill and give a series of loud claps—two, three, or four claps were frequently heard. As evidence of the volume and variety of pelican noises, I made a recording—and the tape-recorder, like the camera, cannot lie.

What of the future? It is most reassuring to know that the villagers of those parts extend a sort of traditional welcome and protection to the visiting pelicans. I wonder if villagers in other parts of the country would do the same, should the pelicans have to move from their present colony?

For if the Kollair Lake is the main source of their fish supply, then the future of the present pelicanry is uncertain due to the fact that this lake is being drained in an agricultural project. I was told that in three or four years' time the lake would practically cease to be. So it seems that alternative nesting sites may possibly have to be found by the birds in the years to come. Perhaps some of the new sheets of water formed by the multi-purpose hydro-electric and irrigation projects in fast developing India may eventually help provide the answer to this problem.

Critical Notes on the Orchidaceae of Bombay State

III. THE GENUS *OBERONIA* LINDL.

BY

H. SANTAPAU, S.J., F.N.I. AND Z. KAPADIA, PH.D.

(*With five plates*)

[*Continued from Vol.* **57** (1) : 135]

The generic name *Oberonia* seems to be derived from Oberon, the King of Fairies, in reference to the strange and variable forms of the plants of this genus. This is one of the more difficult among orchid genera, mostly on account of the minute structure of the flowers. Identification of the genus is simple enough, for the plants are very distinctive in their general appearance ; identification down to the species level is rather difficult on account both of the very small size of the flowers and of their annoying variability.

The genus *Oberonia* is common in most parts of the former Bombay State, as it stood after Independence ; *Oberonia* is particularly common from about Bombay latitude southwards to N. Kanara and beyond. They are usually perennial herbs, but flower at various times in the year. We do hope that these notes with the diagrams of some of the species will be of help to other Bombay botanists.

OBERONIA Lindl.

OBERONIA Lindl. Gen. & Sp. Orch. Pl. 15, 1830, nom. cons. ; Endl. Gen. Pl. 188, 1837 ; Lindl. Fol. Orchid. Oberon. 1852 ; Benth. & Hook. f. Gen. Pl. 3 : 494, 1883 ; Pfitz. in Engl. & Prantl. Pflanzenfam. 2 (6) : 131, 1888 ; Hook. f. Fl. Brit. Ind. 5 : 675, 1898 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 2, 1898 ; Duthie, ibid. 9 (2) : 85, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 233, 1905 ; Schlecht. Orchid. 156, 1927 ; Holttum, Rev. Fl. Malay. 1 : 208, 1953. *Iridorkis* Thou. in Nouv. Bull. Soc. Philom. Paris 1 : 319, 1809. *Iridorchis* Thou. Hist. Pl. Orch. 1822 ; O. Kuntze, Rev. Gen. Pl. 2 : 668, 1891.

Erect or pendulous *epiphytes*. *Stems* usually dense and short, occasionally long and slender. *Leaves* much laterally compressed, with broad overlapping sheaths at the base, ensiform, fleshy, leathery. *Inflorescence* in terminal, dense, sub-cylindric racemes or spikes, which continue to grow at the base after the middle part has matured ; the uppermost flowers usually open first. *Flowers* up to 2 mm., often scarcely 1 mm. long, sessile or on a short stalk and bracteate ; the colour of the flowers is usually inconspicuous, often greenish or greenish yellow. *Sepals* free, nearly equal among themselves, erect or reflexed. *Petals* usually narrower and shorter. *Lip* sessile, concave at the base, fimbriate, entire or more or less 3-lobed. *Column* very short, footless ; clinandrium fairly prominent. *Anther* terminal, opercular, incumbent ; pollinia 4, waxy, yellow, in pairs without caudicles, often attached by a viscid substance at the apices. *Capsules* small, globose or shortly oblong, ridged.

It may be interesting to put down here some general points on the structure of the flowers. Hooker f. mentions that each bract supports 2 flowers ; in Bombay we have noted that each flower is supported by its own individual bract. Some of the species are described as having setaceous sepals and petals ; actually these setaceous structures are prominent hyaline glands which may appear as setae especially in moist flowers from dry herbarium specimens. The tips of the sepals are often curved inwards, and they then seem to be obtuse ; in fact they are sharply acute. In the normal position of the lip the lateral lobes are usually more or less folded over the column, and appear very small ; again careful observation will show that they are often fairly large ; but this can only be seen when the fresh lip is properly spread out. A careful examination of the structure of the lateral lobes is essential, since the separation of species is often based on such a structure.

Type species : *O. iridifolia* (Roxb.) Lindl.

KEY TO THE SPECIES OF *OBERONIA* OF BOMBAY

1. Sepals similar ; lateral lobes of lip not encircling the column ; midlobe of lip usually straight :
    2. Petals and lobes of lip deeply toothed :
        3. Small plants ; lvs. to 4 cm. long ; rachis terete ; flrs. orange, stalked ; sepals & petals erect ; lip clearly 3-lobed, the midlobe with broad oblong lobules .. .. *brachyphylla*
        3. Large plants ; lvs. to 15 cm. long ; rachis flattened ; flrs. golden yellow, ± sessile ; sepals & petals reflexed ; lip obscurely 3-lobed, midlobe 2-lobulate .. .. *iridifolia* var. *denticulata*

2. Petals & lobes of lip ± entire :
    4. Petals broad :
        5. Spikes shorter than leaves ; petals and lip pubescent .. *ensiformis*
        5. Spikes much longer than leaves ; petals and lip glabrous : ..
            6. Lobes of lip large ; midlobe about equal to side lobes .. *recurva*
            6. Lobes of lip very small or 0 ; midlobe 4-5 times larger than side ones :
                7. Inflorescence rachis thickened in fruit, with a few minute scaly bracts ; flrs. ± embedded in rachis ; lip as broad as long, not lobed, denticulate *proudlockii*
                7. Rachis not thickened in fruit, with large serrulate bracts at base ; lip broader across side lobes than across midlobe, which is entire, 2-lobulate .. .. *falconeri*
                7. Rachis not thickened in fruit, with a few or 0 minute bracts ; midlobe broader than lip across side lobes ; midlobe divided at apex into 2 truncate lobules .. .. *verticillata*
    4. Petals, narrow, ± linear :
        8. Lvs. thin ; flrs. long-pedicelled ; lateral lobes of lip up to equal to midlobe, which is divided at apex into 2 diverging lobules *wightiana*
        8. Lvs. fleshy ; flrs. sessile ; lateral lobes longer than midlobe :
            9. Lip longer than broad ; lateral lobes broad, wing-like ; midlobe short ± quadrate, ± 3-lobed at margin .. *platycaulon*
            9. Lip oblong-orbicular ; apex 2-lobulate, lobules orbicular .. .. *brunoniana*
            9. Lip broadly 3-lobed ; midlobe much smaller than lateral lobes .. *santapaui*
1. Sepals unequal ; lateral lobes of lip encircling the column : midlobe of lip usually folded upwards ;

10. Petals broad ovate ; lateral lobes of lip linear-lanceolate, ascending as erect horns around the column, slightly diverging at the tips or not *bicornis*
10. Petals narrow linear ; lateral lobes of lip elongated, filiform, ± aristate meeting beyond the column .. .. .. *tenuis*

ENUMERATION OF THE SPECIES OF *OBERONIA* OF BOMBAY STATE

1. **Oberonia brachyphylla** Blatt. & McC. in J. Bombay nat. Hist. Soc. 35 : 257, t. 2, 1931 (See Plate XI A′-B′).

Small pendulous *epiphytes. Leaves* 0.6-4 × 0.3-1.4 cm. fleshy or thin, ovate to oblong or lanceolate, straight or more commonly the uppermost falcate. *Scape* adnate to the uppermost leaf, bracteate, about 2-5 mm. long, terete. *Inflorescence* 0.8-7 cm. long, somewhat decurved, dense or lax, many-flowered. *Flowers* about 2 mm. long, orange or yellowish orange, more or less whorled, bracteate, with long pedicels. *Bracts* shorter than the pedicels, lanceolate or ovate-lanceolate, acute or acuminate, irregularly erose, gland-dotted. *Sepals* about 0.75 × 0.5 mm., subequal, gland-dotted, acute-mucronulate, entire, erect ; the dorsal one ovate-oblong, the laterals obliquely ovate-subacuminate. *Petals* more or less equal to the sepals, oblong-obovate, narrowed to the base, or even oblong-orbicular, obtuse, slightly retuse, irregularly denticulate. *Lip* 1-1.25 mm., nearly twice the size of the sepals and petals, somewhat quadrangular in outline, 3-lobed, 3-nerved, distinctly gland-dotted ; lateral lobes broad, irregularly pectinate, the lip across the lateral lobes about equal to or slightly broader than across the midlobe ; midlobe 2-lobulate with a broad or narrow sinus in between the lobules, the latter slightly divergent, oblong, irregularly denticulate or pectinate at the apex or even all around. *Ovary* with pedicel about 1 mm. long. *Capsules* up to 5 mm. long, ovoid or obovoid, long-pedicelled.

Flowering and *Fruiting* : March.

Occurrence in Bombay : *Bell* ; *Kapadia* 1857, 2853-2857.

Distribution : Apparently endemic in N. Kanara.

Notes : Blatter & McCann described their species from detailed illustrations prepared by T. R. Bell and Miss Bell ; these illustrations were drawn directly from live specimens. As no type was designated for the species, and further as there is no type material at all, we hereby establish the specimen, *Kapadia* 2855, as the Neotype of *O. brachyphylla* Blatt. & McC.

2. **Oberonia iridifolia** Lindl. var. **denticulata** Hook. f. Fl. Brit. Ind. 5 : 676, 1890 ; Fischer, Fl. Pres. Madr. 1406, 1928. *O. denticulata* Wight, Icon. 5(1) : 3, t. 1625, 1851 ; Lindl. 2. (See Plate XII).

Erect or occasionally pendulous *epiphytes. Leaves* 4-15 × 1.5-2.5 cm., fleshy, broadly ensiform, ovate-oblong to oblong-lanceolate, often subfalcate, acute to subacuminate. *Scape* 2-5 cm. long, bracteate or ebracteate, flattened, 2-angled, somewhat twisted, often adnate to the uppermost leaf particularly in young plants. *Inflorescence* 7-20 cm. long, decurved or rarely straight, dense. *Flowers* about 2 mm. across, imbricating or in sub-verticils, golden yellow, bracteate, sessile. *Bracts* 2 × 1 mm., ovate to elliptic, acute, irregularly crenulate, convolute, sheathing the sessile ovary. *Sepals* 1 × 0.75 mm., equal, broadly ovate-rotund or suborbicular, acute-mucronulate, 1-nerved. *Petals* 1 × 0.6 mm., ovate-elliptic, obtuse to rarely subretuse, irregularly jagged, 1-nerved. *Sepals* and *petals* reflexed and resting on the ovary. *Lip* 1.5 × 2 mm., obscurely 3-lobed ; lateral lobes pectinately erose ; terminal lobe 2-lobulate with an unequal broad sinus, the lobules dentate or more often bidentate ; nerves of the lip 3, the lateral ones sinuous, the central one straight. *Column* stout, broad, sessile, over 1 mm. in length. *Anther* transversely oblong-orbicular with a small rounded apex, greenish-white. *Capsule* sessile, broadly ovoid, 5 × 2 mm.

Flowering : August to September. *Fruiting* : October to December.

Occurrence in Bombay State : KONKAN : Tansa, *Santapau* 16030 ; *Kapadia* 731, 1638. N. KANARA : Gundh, *Bole* 1497 ; *Kapadia* 1711-1717.

This species has been recorded from Bombay State for the first time.

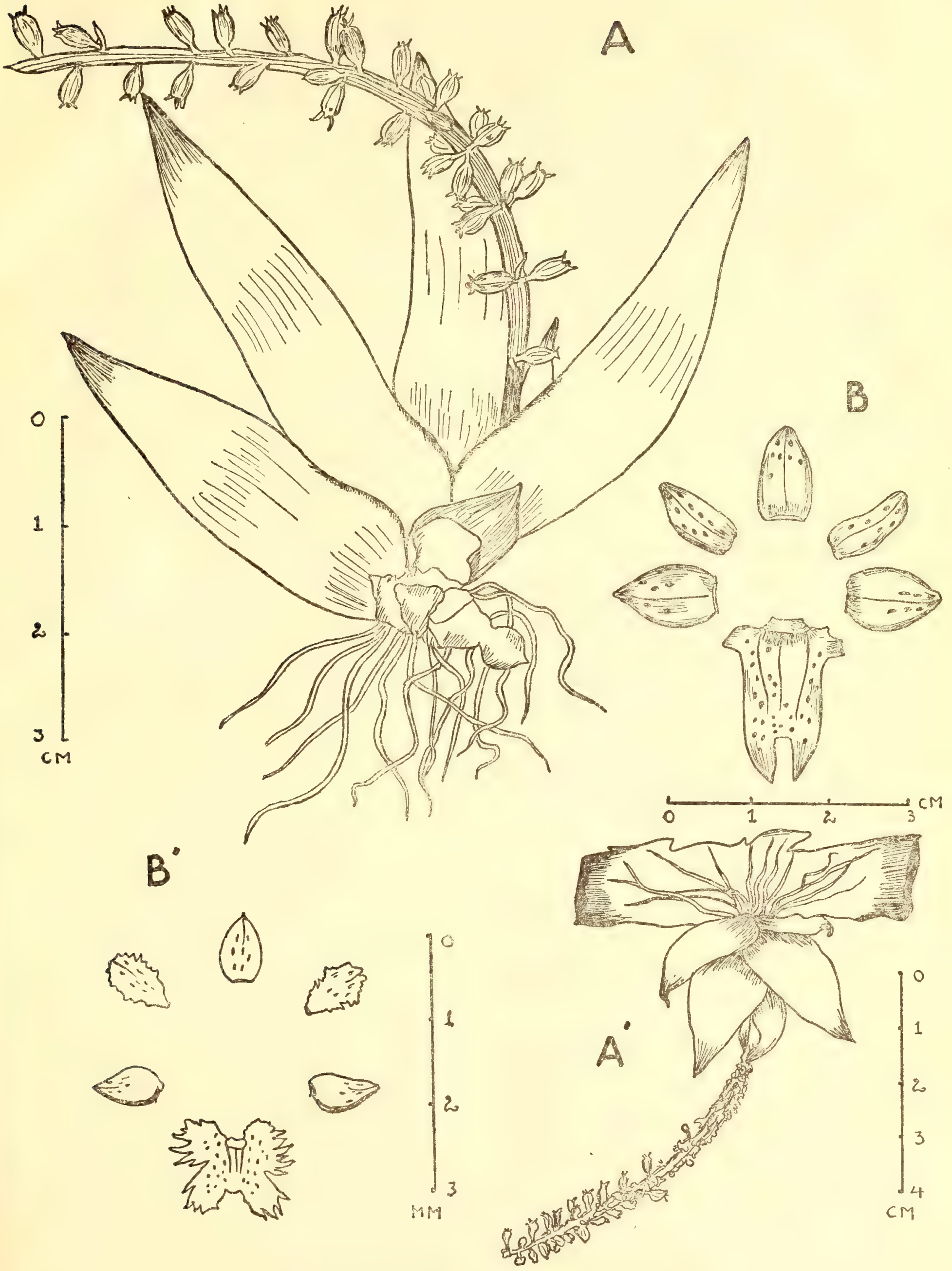
Distribution : *O. iridifolia* Lindl. is a very variable species and is widely distributed all over India. The var. *denticulata* Hook. f. is restricted to south India ; we have noted it in Bombay for the first time.

Notes : We have examined the specimen *Fischer* 3509 labelled *O. brunoniana* Wt. in 1920 ; the name was changed by Fischer himself to *O. lindleyana* Wt. The plant, however, belongs to *O. iridifolia* var. *denticulata* Hook. f.

In Wight's description of *O. denticulata* there is no mention of the erose nature of the petals ; Wight's Icon 1625 shows the petals to be smoothly entire. We have observed the petals to be distinctly and irregularly jagged.

3. **Oberonia ensiformis** (Sm. ex Rees) Lindl. Fol. Orchid. Oberon. 4, 1852 ; Hook. f. 679 ; Grant, Orch. Burma 29, 1895 ; King & Pantl. 9, t. 9 ; Duthie 86 et Fl. Upp. Gang. Pl. 3 : 183, 1920 ; Brühl, Guide Orch. Sikk. 37, 1926 ; Fischer 1405. *Malaxis ensiformis* Smith in Rees, Cycl. 22 : n. 14, 1812 ; Reichb. f. in Walp. Ann. 6 : 212, 1861. *Oberonia trilobata* Griff. Notul. 3 : 273, 1851. *O. acaulis* Hook. Bot. Mag. t. 5056, 1858, (non. Griff. 1851). *Iridorchis ensiformis* O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891. (See Plate XIII).

Large pendulous *epiphytes. Leaves* 6-28 × 0.5-1.5 cm. fleshy,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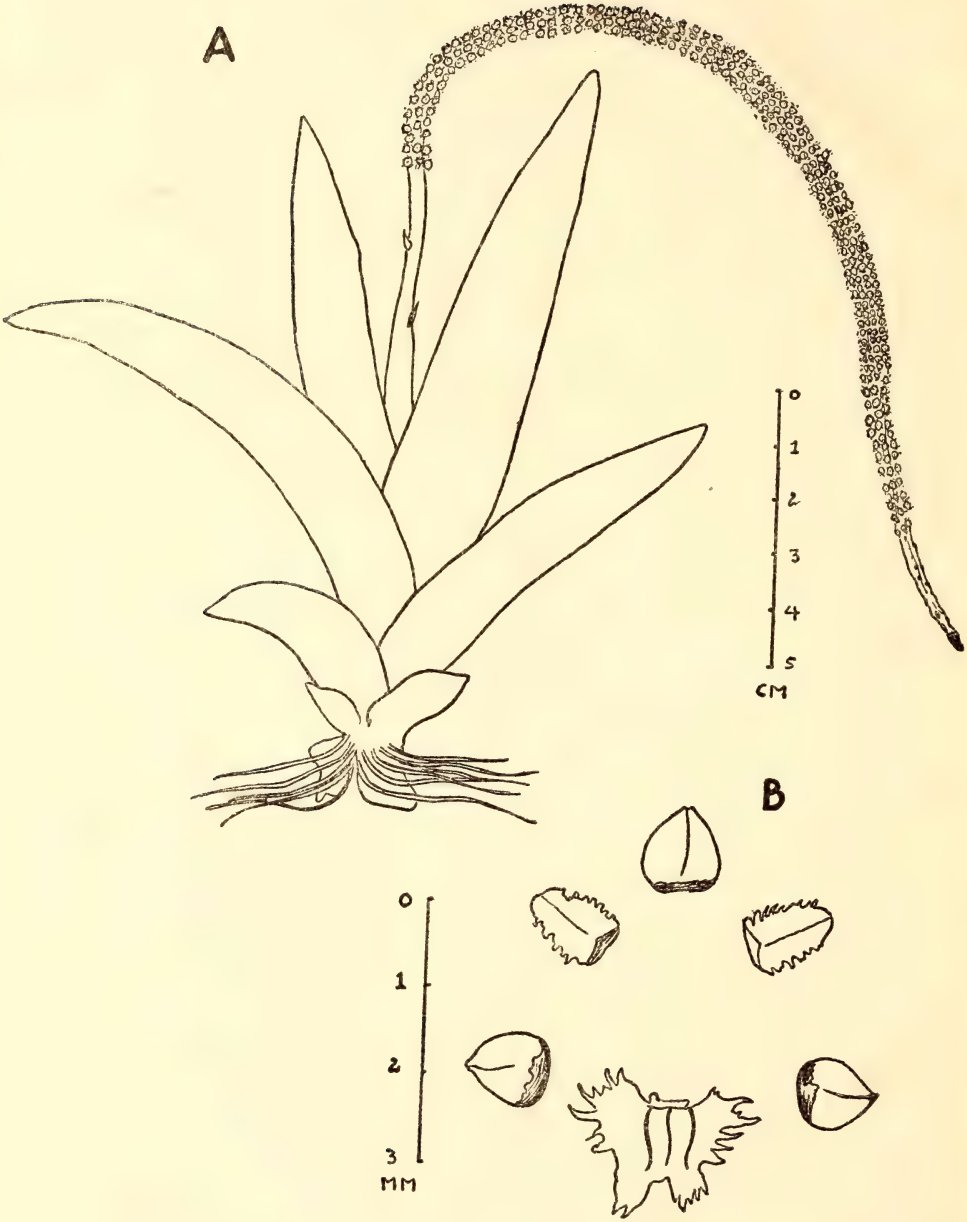
A-B. *Oberonia falconeri* Hook. f. ; A′-B′. *O. brachyphylla* Blatt. & McC.
A-A′. Whole plant ; B-B′. Sepals, petals, and lip.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Oberonia iridifolia var. *denticulata* Hook. f.
A. Whole plant ; B. Sepals, petals, and lip.

ensiform, acuminate, falcate or straight, generally all curving in one direction. *Inflorescence* much shorter than the leaves, 6-14 cm. long ; peduncle fleshy, pale brown, terete, sparsely bracteate ; bracts lanceolate, minute, pale yellow. *Flowers* about 2 mm. long, subsessile, bracteate, in more or less clear verticils. *Bracts* longer, ovate-oblong, erose, glabrous, completely sheathing the ovary, their apices acute and recurved. *Sepals* and *petals* reflexed on the ovary, gland-dotted, entire, subacute. *Sepals* subequal, broadly ovate, glabrous. *Petals* ovate, pubescent with blackish stiff bristles. *Lip* about twice as long as the sepals or petals, 3-lobed, of a much darker colour, turning somewhat black on drying ; lateral lobes fairly large, rounded, stiffly pubescent ; the terminal lobe somewhat obreniform in outline, 2-lobulate, pubescent with bristle-like black hairs, the lobules somewhat rounded, separated by a wide subtruncate sinus ; the terminal lobe is separated from the lateral ones by an oblong, completely glabrous mesochile, which has 2 blister-like projections on the sides. *Ovary* very shortly stalked, pale yellowish, ridged. *Capsule* 4-6 × 2-3 mm., ovoid, strongly ribbed, subsessile.

Fruiting : November onwards.

Occurrence in Bombay : N. KANARA Dandeli, *Kapadia* 1671-1672, 1682 ; Yellapur, *V. Patel* 1847 ; *Kapadia* 2350-2352 ; Kumbelli Mines, about 17 miles from Supa, *Kapadia* 2662-2663.

This species is of fairly widespread occurrence in N. Kanara ; strangely enough it has not been recorded for Bombay State by any of the earlier workers. It constitutes a new record for this area.

Distribution : *India* : Dehra Dun and up to 1000 m. on the adjacent Himalayas, extending eastwards to Sikkim and Khasia Hills, southwards to N. Kanara and the Nilgiris. *World* : India, Nepal.

Notes : This species is easily distinguished by its large ensiform leaves, all of which usually curve in the same direction, and by the stout inflorescence, which,. however, is always much shorter than the leaves. It is closely allied to *O. ferruginea* Parish ex Hook. f. ; the latter has completely glabrous flowers.

4. **Oberonia recurva** Lindl. in Bot. Reg. misc. 8, 1839, et Fol. Orchid. Oberon. 5, 1852 ; Dalz. & Gibs. Bomb. Fl. 260, 1861 ; Hook. f. Icon. Pl. t. 1784 A, 1888, et Fl. Brit. Ind. 5 : 680, 1890 ; Gammie in J. Bombay nat. Hist. Soc. 16 : 564, 1905 ; Cooke, Fl. Pres. Bomb. 2 : 676, 1907 ; Fischer 1406 ; Blatt. & McC. 257 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 288, 1953. *Oberonia setifera* Lindl. Fol. Orchid. Oberon. 3, 1852. *Malaxis recurva* et *setifera* (Lindl.) Reichb. f. in Walp. Ann. 6 : 210, 212, 1861. *Iridorchis recurva* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891.

Pendulous *epiphytes*. *Leaves* 0.5-5 × 0.3-1.7 cm., ovate to lanceolate, at times subfalcate (particularly the uppermost one), acute to acuminate. *Peduncles* 0-1 cm. long, adnate to the uppermost leaf, with minute hyaline subulate bracts. *Racemes* 1-11.5 cm. long, straight or recurved, dense or rarely lax. *Flowers* 1.5-2 mm. across, imbricating, bracteate, pedicellate, pale orange to deep brick-red. *Bracts* 1-2 × 0.5 mm., shorter or slightly longer than the flowers, gland-dotted, 1-nerved, ovate-acuminate to subulate, subentire to erose, acuminate. *Sepals* 0.5-0.75 mm. long, subequal, ovate, entire, more or less gland-dotted, 1-nerved ; lateral sepals concave, very often mucronulate ; the dorsal one subconvex, ovate-oblong, obtuse, at times subacute. *Petals* 0.5-0.75 mm. obovate-oblong or obovate-spathulate, truncate or truncate-retuse or obtuse-retuse, subentire to erose, more or less gland-dotted along the single midnerve. *Lip* deep red, usually of a much darker colour than the petals and sepals, very variable in shape and size, 3-lobed, 0.75-1 mm. long, equal to or nearly twice as long as the sepals or petals, densely or very sparsely gland-dotted, with a small concave disc just below the anther, 3-nerved. Lateral lobes of lip large, rounded, rarely subtruncate, subentire, erose ; width of the lip across lateral lobes ± equal to that across the midlobe ; midlobe 2-lobulate, obcordate-oblong, subentire to erose ; apices of lobules acute to truncate or obtuse, subentire or erose ; sinus between the lobules broad or narrow, with or without a small apiculum in between. *Column* very small with a transversely oblong stigmatic surface. *Anther* opercular, yellowish green. *Ovary* with *pedicel* 0.75-1.5 mm. long. *Capsule* 2-5 × 2 mm., subrotund to obovate-oblong ; pedicel 0.5 mm. long.

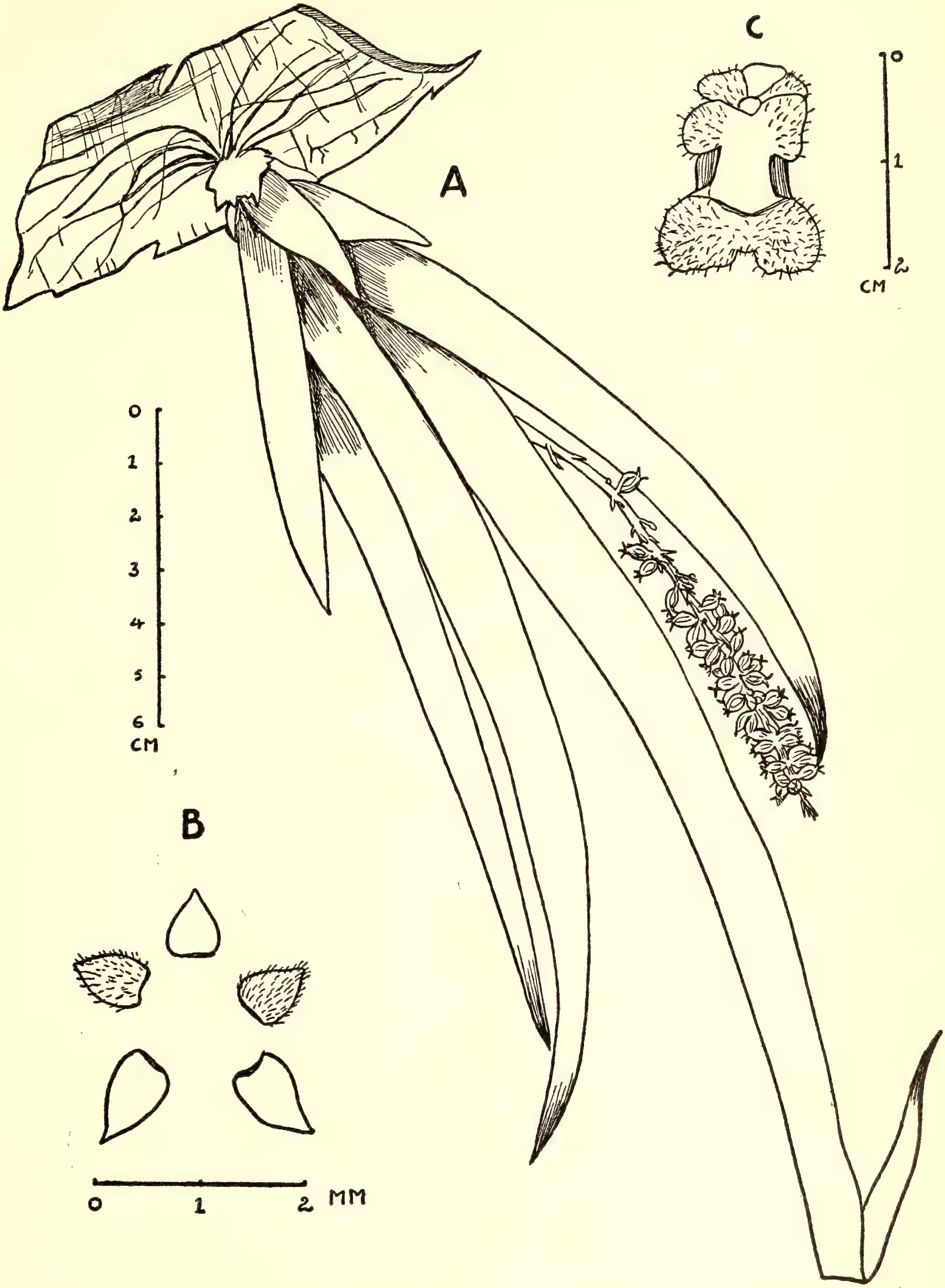
Flowering : November to February. *Fruiting* : December to July.

Occurrence in Bombay State : KONKAN : *Law* ; Thana, cultivated, *Kapadia* 1105. W. GHATS : Kasara, *Kapadia* 902 ; Khandala, *D. K. Patel* ; *Santapau* 233.4, 3622, 10788 ; *C. Saldanha* 1152 ; *Kapadia* 507, 529, 1062, 1834-1835 ; Lonavla, *Gammie* ; *Hallberg* ; *Kapadia* 538, 1047, 1054 ; Mahableshwar, *Cooke* ; *Santapau* 11819, 11913 ; *Kapadia* 500, 600-601, 983, 1928-1929 ; Mahableshwar-Pratapgad, *Agharkar* ; Pratapgad, *Bole* 1078. DECCAN : Koina Valley, *Kapadia* 2906-2907. N. KANARA : Londa, *Santapau* 10854; Kumbelli Mines, about 17 miles from Supa, *Kapadia* 2565-2567, 2675-2677, 2764-2766 ; Yellapur, *Kapadia* 2868 ; Castle Rock, *Santapau* 17655, 17831, 17909 ; *Kapadia* 2814 ; Anmod, *Kapadia* 1914 ; Dandeli, *Kapadia* .

Distribution : Konkan, W. Ghats, Deccan, N. Kanara, Travancore.

Notes : We have noticed this species epiphytic on *Careya arborea* Roxb., *Ficus* sp., *Carissa congesta* Wt., *Euphorbia neriifolia* L., *Randia brandisii* Gamble and *Ixora brachiata* Roxb. This species is very variable in the shape and size of the various floral parts.

Blatter & McCann and Santapau cite King & Pantling in Ann. R.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Oberonia ensiformis Lindl.
A. Whole plant ; B. Sepals and petals ; C. Lip.

Bot. Gard. Calcutta 8 : t. 9, for *O. recurva* Lindl. This plate is *O. ensiformis* Lindl., a totally different species ; *O. recurva* Lindl. has not been recorded from Sikkim Himalayas.

5. **Oberonia recurva** Lindl. var. **lingmalensis** (Blatt. & McC.) Sant. & Kapadia, stat. nov. *O. lingmalensis* Blatt. & McC. in J. Bombay nat. Hist. Soc. 35 : 255, 1931.

After a very careful examination of a number of fresh plants collected from the type locality and a sheet in Sedgwick herbarium, *Sedgwick* 4626, identified by Blatter himself as *Oberonia lingmalensis* Blatt. & McC., we have come to the conclusion that the latter is but an intermediate form between *O. verticillata* Wt. and *O. recurva* Lindl. with greater affinities to the latter.

The only constant distinguishing characters between the present variety and *O. recurva* Lindl. are : (1) flowers in the variety have longer pedicels, and are placed in distinct verticils, not imbricating ; (2) the leaves in the variety are acute or acuminate. Often the lateral lobes of the lip are only slightly smaller than those normally met with in *O. recurva* Lindl., definitely not as minute as in *O. verticillata* Wt.; with the latter species it can be compared only in the arrangement of the flowers.

We have, then, reduced the plants with narrower and more acuminate leaves, and with verticillate or subverticillate, long-pedicelled flowers, to a variety of *O. recurva* Lindl.

Flowering and *Fruiting* : September to February.

Occurrence in Bombay State : KONKAN : Thana, *Bell.* W. GHATS : Mahableshwar, *Sedgwick* 4626 ; *Santapau* 12519, 13169 ; *Bole* 409 ; *Kapadia* 956, 967, 1832, 2065. N. KANARA : *Bell.*

Distribution : Konkan, W. Ghats, N. Kanara.

6. **Oberonia proudlockii** King & Pantl. in Journ. As. Soc. Bengal II, 66 : 580, 1897 ; Fischer 1407. *O. sedgwickii* Blatt. & McC. in J. Bombay nat. Hist. Soc. 35 : 257, 1931.

Small pendulous *epiphytes. Leaves* 0.7-4 × 0.2-1.5 cm., very variable in shape and thickness, oblong to elliptic, or ovate to lanceolate, acute or rarely subacuminate, fleshy or rarely very thin. *Scape* 2-10 mm. long, adnate to the uppermost leaf, with minute, hyaline ovate or ovate-oblong bracts. *Inflorescence* 1-6 cm. long, straight or decurved ; rachis fleshy, considerably thickened in fruit. *Flowers* 1.25 × 1-1.25 mm., somewhat laxly imbricate, more or less sunk in the fleshy rachis and scarcely appearing out of the general outline, subsessile, bracteate. *Bracts* 1 × 0.75 mm., pale yellowish green, slightly longer than the ovary and completely sheathing it, ovate-oblong, irregularly serrulate, acute, gland-dotted. *Sepals* 0.75 × 0.5 mm., subequal, 1-nerved, gland-dotted ; the dorsal one ovate, acute or sub-obtuse ; the lateral obliquely broadly ovate-acuminate, reflexed, lying at right angles to the dorsal sepal below the lip. *Petals* slightly shorter than sepals, reflexed, faintly 1-nerved, gland-dotted, entire or slightly erose, slightly dilated about the middle, somewhat spathulate, acute or subobtuse. *Lip* 0.6-0.75 × 0.75-1 mm., broader than the sepals, entire, gland-dotted, obovate-orbicular or quadrately-orbicular, erose or irregularly denticulate ; apex usually somewhat 2-lobulate with a broad or narrow sinus in between ; occasionally the lobules not distinct. Disc of the lip orbicular, distinct, 3-nerved. *Column* minute, yellow. *Anther* minute. *Ovary* together with the very short *pedicel* 0.75 × 0.5 mm., broadly obovate, ribbed. *Capsule* 3 × 1.5 mm., obovoid-oblong, ribbed.

Flowering and *Fruiting* : March.

Occurrence in Bombay : N. KANARA : Anmod, *Kapadia* 1863, 1906, 1915 ; Castle Rock, *Sedgwick* ; *Kapadia* 2781, 2796-2797.

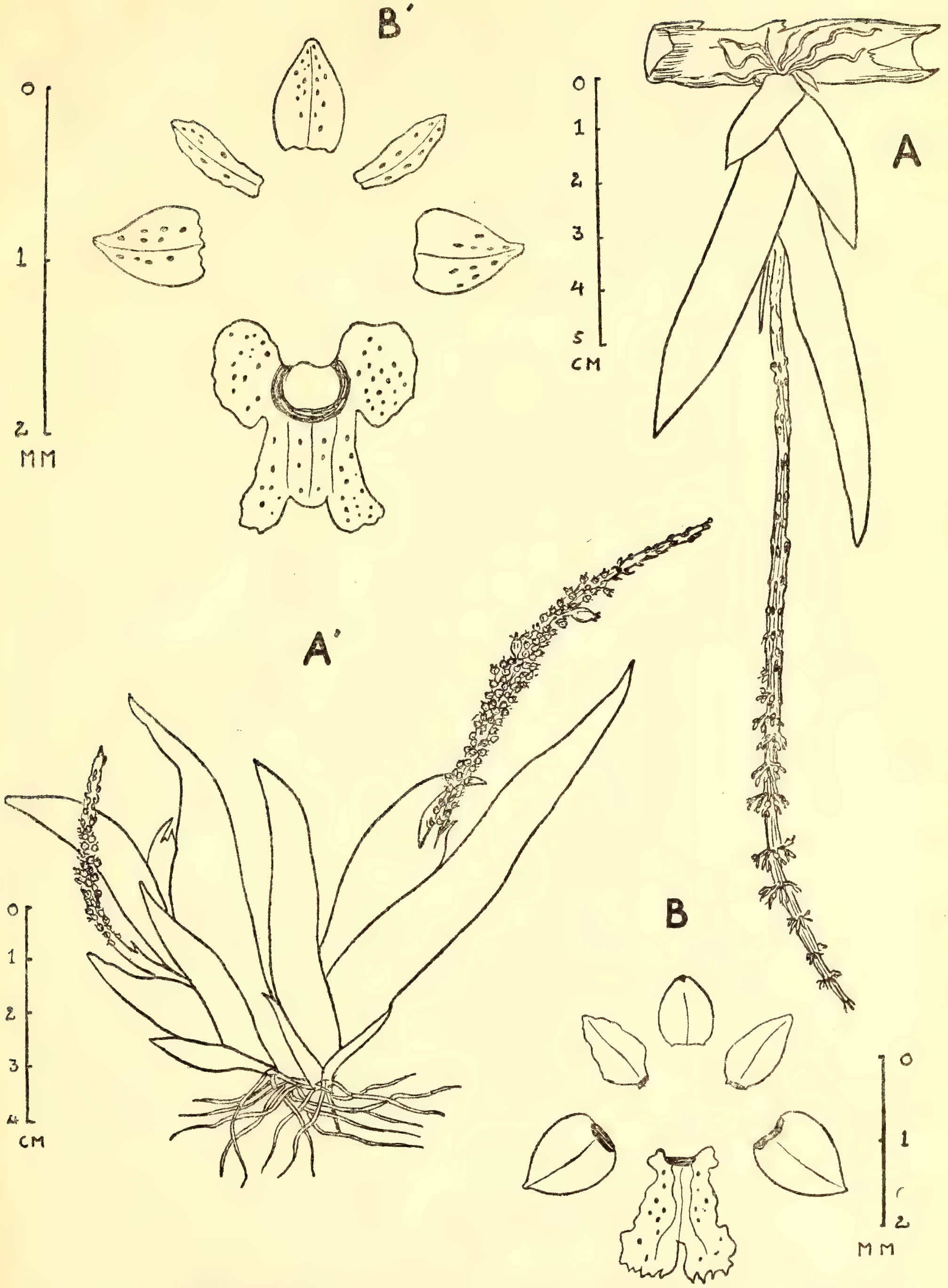
Distribution : N. Kanara, Nilgiris.

Notes : Our specimens have been collected from the type locality, Castle Rock, of *O. sedgwickii* Blatt. & McC. The latter species seems to be identical with *O. proudlockii* King & Pantling. It may be pointed out that certain characters, which are very distinctive of this species, have not been mentioned by Blatter & McCann such as (a) the considerably thickened rachis in fruits, (b) the peculiar way of the flowers being sunk in the fleshy rachis, (c) and the lip irregularly denticulate on the margin. Blatter & McCann describe the petals for their species as linear ; King & Pantling state they are ovate-lanceolate. A careful examination of a number of flowers has shown that the petals in their reflexed position appear narrowly linear, but actually on dissection they are broad, oblong, slightly dilated about the middle.

We have found this species to be epiphytic on *Careya arborea* Roxb. and *Terminalia* sp. in open deciduous forest.

7. **Oberonia falconeri** Hook. f. Icon. Pl. t. 1780, 1888, et Fl. Brit. Ind. 5 : 678, 1890 ; Prain, Beng. Pl. 1003, 1903 ; Gammie 564 ; Duthie 2, t. 94, et Fl. Upp. Gang. Pl. 3 : 183, 1920 ; Cooke 676 ; Haines, Bot. Bih. Or. 1164, 1924 ; Fischer 1406 ; Blatt. & McC. 256. *Iridorchis falconeri* (Hook. f.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891. (See Plate XI A-B).

Erect or pendulous *epiphytes. Leaves* 2-9 × 0.5 cm., coriaceous, oblong-lanceolate, subfalcate, acute or subacuminate. *Scape* short, covered by hyaline, subulate, irregularly serrulate bracts, more so at the base. *Inflorescence* 2-14 cm. long, erect or curved, laxly many-flowered ; rachis stout, strongly grooved, more so in fruit. *Flowers* spiral to subverticillate, about 1.5 mm. across, greenish yellow, bracteate, shortly pedicellate. *Bracts* 2.5-3.5 × 0.7-1 mm., hyaline, shorter or longer than the flowers, sheathing round the ovary, oblong-lanceolate, subulate, irregularly denticulate, glabrous, 1-nerved. *Sepals* 1.25 × 0.75 mm., yellow, obtuse, entire, faintly 1-nerved, sparsely speckled with glands to-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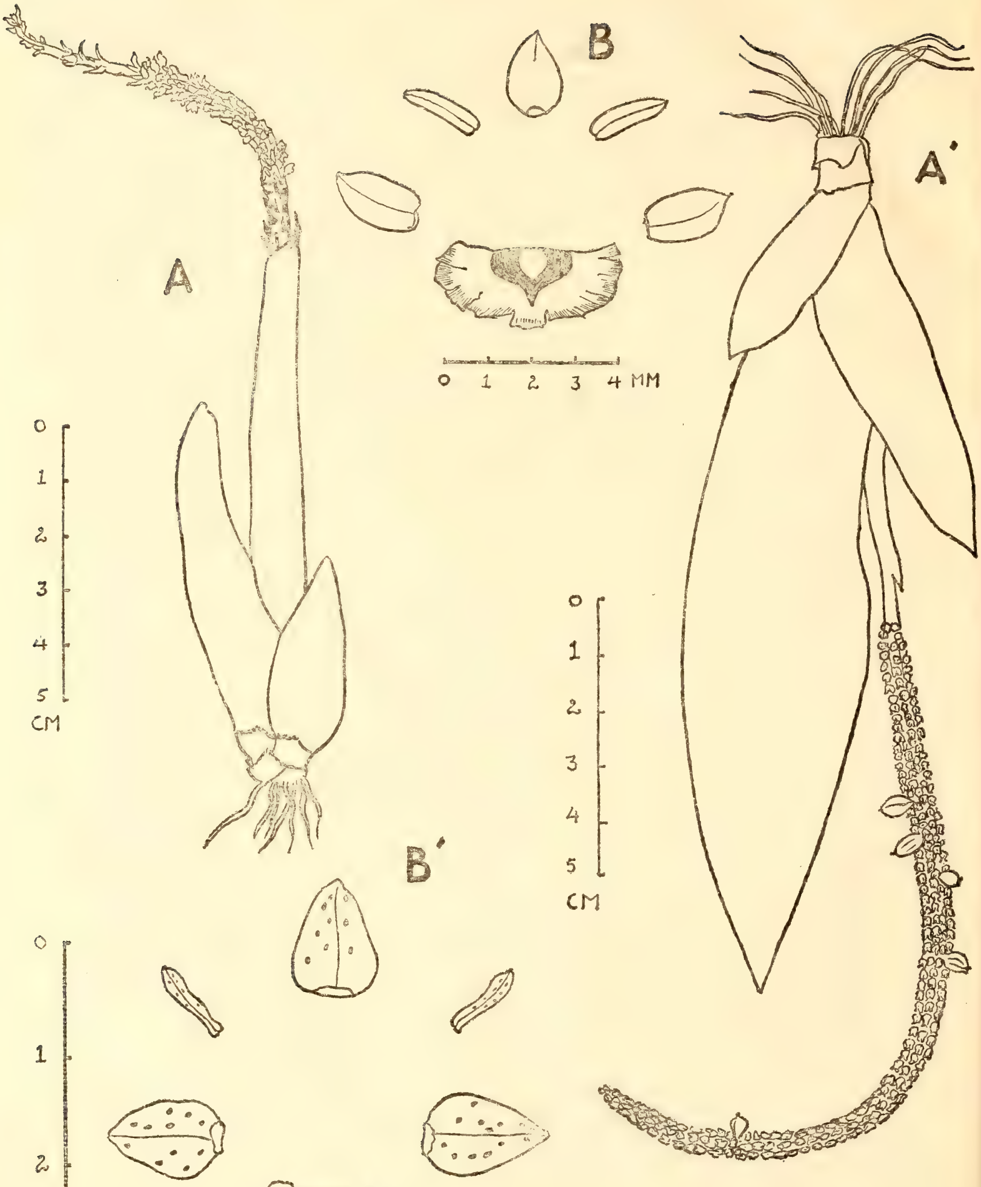
A-B. *Oberonia verticillata* Wt. A′-B′. *O. wightiana* Lindl.
A-A′. Whole plant ; B-B′. Sepals, petals, and lip.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A-B. *Oberonia platycaulon* Wt. A′-B′. *O. brunoniana* Wt.
A-A′. Whole plant ; B-B′. Sepals, petals, and lip.

wards the apex ; the dorsal one oblong-ovate, slightly narrower than the lateral ones ; the lateral sepals broadly ovate. *Petals* 1.2 × 0.5 mm., yellow, oblong-ovate, subfalcate, obtuse, entire, glabrous, 1-nerved, sparsely gland-dotted. *Lip* 2 × 1.5 mm., greenish-yellow, obovate-oblong or oblong in outline, 3-lobed ; the lateral lobes small, tooth-like, rounded, truncate, rarely subretuse ; midlobe broad, about 4-5 times as long as the lateral ones, oblong, faintly wavy on the margins, 2-lobulate about a third from the apex ; lobules parallel or incurved towards each other, subacute or obtuse, with a broad subtruncate sinus ; nerves of the lip 3, the lateral ones sinuate, middle one straight, practically up to the sinus. *Column* small, subquadrate, transversely oblong, yellow. *Anther* white, broadly ovate, truncate at the apex, rarely subretuse. *Capsule* 4 × 2 mm. obovoid, strongly ribbed, shortly stalked; pedicels about 1 mm. long.

Flowering : September. *Fruiting* : October to December.

Occurrence in Bombay : DANGS : Waghai, *Santapau* 20103 ; *Kapadia* 1161, 1439 ; Susarda, *Kapadia* 713. KONKAN : *Law* ; *Woodrow* ; Thana, *Ryan* ; Kalyan, *Millard* ; Tansa, *Kapadia* 748. N. KANARA : Alnawal-Dandeli, *Kapadia* 1654; Dandeli, *Kapadia* 1668 ; Yellapur, *Kapadia* 1763, 1973, 2348-2349.

Distribution : *India* : Tropical Himalaya, Kumaon, Dehra Dun, Bihar, Chota Nagpur, Dangs, Konkan, N. Kanara, Mysore hills at 1000 metres, Rampa Hills at 600 metres. Vizagapatam hills at 700 metres. *World* : India, Nepal.

Note. This species can easily be distinguished by the strongly grooved rachis ; this is covered by hyaline, subulate, irregularly serrulate, loosely sheathing bracts at the base. It is usually found in open forest, epiphytic on *Tectona grandis* L.f., rarely on *Terminalia* sp.

8. **Oberonia verticillata** Wight, Icon. 5 (1) : 3, t. 1626, 1851 ; Lindl, 3, (excl. aliq. var.) ; Hook. f. 678 ; Fyson, Fl. Nilg. Puln. Hill-Tops 383, 1915 ; Fischer 1406 ; Blatt. & McC. 255. *Malaxis verticillata* (Wt.) Reichb. f. in Walp. Ann. 6 : 211, 1861. *Iridorchis verticillata* (Wt.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891. *Oberonia verticillata* var. *longibracteata* Blatt. & McC. in J. Bombay nat. Hist. Soc. 35 : 255, 1931. *O. spiralis* Blatt. & McC. in J. Bombay nat. Hist. Soc. 35 : 256, 1931 (non Griff. 1851, nec Lindl. 1852). (See Plate XIV A-B).

Pendulous *epiphytes.* Leaves 3-20 × 0.7-1.5 cm., oblong, narrowly ensiform, acuminate, fleshy. *Peduncle* about 3 cm. long, bracteate to the base, not joined to the uppermost leaf. *Inflorescence* up to 25 cm. long, falcately curved or nearly straight. *Flowers* in distinct verticils or spirals (each whorl about 2-3 mm. apart), shortly pedicelled, bracteate, yellow. *Bracts* 1.5-2 mm. long, slightly longer than the flowers or equalling them, oblong, acute or with a short acumen, much erose or subfimbriate, ensheathing the ovary and the pedicel, sparsely gland-dotted. *Sepals* subequal; the dorsal one 0.75 × 0.75 mm., ovate-oblong, obtuse, mucronulate, 1-nerved, subconcave ; the lateral ones bigger, 1 mm. long, nearly as broad, broadly ovate, mucronate, concave, 1-nerved. *Petals* slightly smaller than the lateral sepals, ovate, acute or subobtuse, crenulate or subentire, 1-nerved. *Lip* 1.75-2.25 mm. long, nearly twice the length of sepals or petals, cuneate-obovate in outline, 3-nerved, sparsely gland-dotted, 3-lobed ; lateral lobes minute, ear-like, (not absent, as stated by Blatter & McCann) ; width of lip across lateral lobes less than half that across the midlobe ; midlobe cuneate-obovate, crenulate, 2-lobulate towards the apex ; lobules broad, rounded or truncate, dentate or erose at the apex, with usually a narrow sinus in between. *Column* small. *Anther* opercular, yellowish. *Ovary* with the short *pedicel* about 2 mm. long, greenish yellow.

Flowering : July to October. *Fruiting* : September onwards.

Occurrence in Bombay: N. KANARA: Yellapur, *Kapadia* 1991-1992, 2259, 2886-2887 ; Sirsi, *Hallberg & McCann* 35059 ; *Santapau* 18649 ; *Kapadia* 2446-2448.

Distribution : *India* : N. Kanara, W. Ghats of S. India, Nilgiris, Pulneys, Salem hills. *World* : Ceylon, India.

Notes : Our Yellapur specimens have floral bracts equal to or even slightly longer than flowers ; this variation has been observed in the same inflorescence, and is of frequent occurrence in the genus *Oberonia*. This is why we have united var. *longibracteata* Blatt. & McC. with *O. verticillata* Wt.

Careful examination of fresh specimens from Yellapur (type locality of *O. spiralis* Blatt. & McC.) and Sirsi, has shown to us that in floral structure there is hardly any difference between *O. spiralis* Blatt. & McC. and *O. verticillata* Wt. Some of the plants have flowers in spirals, others in distinct verticils ; in a few specimens the flowers are arranged in distinct spirals on the lower part of the rachis, while in the upper part they are in pure uninterrupted whorls.

9. **Oberonia wightiana** Lindl. in Bot. Reg. misc. 9, 1839 ; Wight, Icon. 5 (1) : 3, t. 1627, 1851 ; Lindl. 5 ; Hook. f. Icon. Pl. t. 1784 B, 1888, et Fl. Brit. Ind. 5 : 683, 1890 ; Fyson 383 ; Fischer 1407 ; Blatt. & McC. 258. *O. stachyoides* A. Rich. in Ann. Sc. nat. (ser. 2) 15 : 15, t. 1 A, 1841. *O. arnottiana* Wight, Icon. 5 (1) : 3, t. 1628, 1851 ; Blatt. & McC. 258. *Malaxis wightiana* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891. (See Plate XIV A′-B′).

Pendulous *epiphytes*. *Leaves* 4-9 × 0.7-1.5 cm., ensiform, often subfalcate, acute or acuminate, the uppermost often sub-subulate, thin, not fleshy. *Peduncle* practically 0, joined to the uppermost leaf. *Inflorescence* up to 10 cm. long, slightly curved ; flowers in rather lax, subverticillate racemes, pedicellate, bracteate. *Pedicel* with *ovary* about 2 mm. long. *Bracts* 1.5 × 0.75 mm., shorter than the pedicel, ovate-acuminate, (acumen often rather long drawn out), subentire or erose, gland-dotted. *Sepals* 1 × 0.75 mm., subequal, broadly ovate, gland-dotted, entire ; the lateral ones sharply acute or mucronulate, concave ; the dorsal sepal obtuse or subacute, not concave. *Petals* linear, shorter than the sepals, acute, entire or very slightly erose, gland-dotted. *Lip* 1.75 mm. long, nearly twice as long as the sepals, 3-lobed with a small concave disc ; nerves 3 starting from the disc and going up to the sinus ; lateral lobes 0.75 × 0.5 mm., rounded, somewhat oblong-reniform, subentire or erose, gland-dotted, more or less erect and enfolded over the column ; width of lip across the lateral lobes larger than that across the midlobe ; midlobe obcordate-oblong, 2-lobulate, sinus broad with or without a very small mucro within, lobules diverging, rounded, erose or denticulate. *Column* very small. *Anther* opercular, minute. *Capsules* 5 × 3 mm., pedicelled, obovoid ; pedicels about 1 mm. long.

Flowering and *Fruiting* : March.

Occurrence in Bombay State : N. KANARA : Yellapur, *Sedgwick* ; Haliyal, *Sedgwick* ; Anmod, *Sedgwick*, *Kapadia* 1872-1873.

Distribution : *India* : N. Kanara, Nilgiris, Pulneys. *World* : Ceylon, India.

Notes : This species is usually found pendulous on *Artocarpus* trees. As to the variations in the floral structure we quote Lindley (in *Fol. Orchid.*) : ' Flowers pale green. This seems to vary more than usual in the present genus, in the form of the lip, the front lobes of which are either ligulate and denticulate at the point or entire ; or short and acute ; and these differences seem to occur on the same or otherwise undistinguishable individuals. I can find nothing sufficient to separate my learned friend Wight's *O. arnottiana*, whose bracts appear exactly the same as in *O. wightiana* and by no means furnished with long cilia, as is represented by his draughtsman '.

10. **Oberonia brunoniana** Wight, Icon. 5 (1) : 3, t. 1622, 1851 ; Lindl. 2 ; Hook. f. 681 ; Grant, Orch. Burma 29, 1895 ; Cooke 677 ; Fischer 1406 ; Blatt. & McC. 257 (non t. 3, quae est *O. ensiformis*). *Malaxis brunoniana* (Wt.) Reichb. f. in Walp. Ann. 6 : 209, 1861. *Iridorchis brunoniana* (Wt.) O. Kuntze, Rev. Gen. Pl. 2 : 699, 1891. (See Plate XV A′-B′).

Erect or pendulous *epiphytes*. *Leaves* 4-15 × 1-3.5 cm., very succulent, obovate to linear-oblong, often subfalcate, acute, purplish-brown to brown in colour, not green. *Scape* 1.5-3 cm. long, 2-angled, usually furnished with a small leaf-like bract at its apex just below the inflorescence. *Spike* 5-20 cm. long, 5-6 mm. broad, erect or recurved, stiff ' like a rat's tail ' (Hooker f.). *Flowers* densely imbricate, ' olive-brown in colour' (Wight), bracteate, subsessile, a little less than 2 mm. across. *Bracts* 1.5 × 1 mm., shorter than the flowers, oblong-ovate to ovate, acute, irregularly denticulate, 1-nerved, sparsely gland-dotted. *Sepals* 1 × 0.75 mm., subequal, gland-dotted, ovate, acute-mucronulate, entire, glabrous, 1-nerved ; lateral sepals spreading, concave ; dorsal sepal narrower. *Petals* 0.75 mm. long, shorter than the sepals, narrowly linear, acute or subobtuse, entire, glabrous, sparsely gland-dotted, 1-nerved. *Lip* 1.25 × 1.25 mm. quadrately-oblong, 3-lobed, densely gland-dotted outside the large concave disc, the latter extending practically up to the sinus ; lateral lobes of lip oblong, obtuse, irregularly crenulate, longer than the midlobe ; midlobe 2-lobulate, lobules rounded, subobclavate, irregularly crenulate, the sinus deep, wide, usually with a minute mucro ; nerves 3, all within the disc. *Column* 0.5 × 0.5 mm., quadrate, with a transversely elliptical stigmatic surface. *Anther* small, obovate, yellowish. *Ovary* with short *pedicel* 1 × 0.5 mm., inversely flask-shaped, ribbed. *Capsule* 5 × 3 mm., ellipsoid on a very short stalk.

Flowering and *Fruiting* : February to March.

Occurrence in Bombay: N. KANARA: *Bell* ; Kalanadi, *Ritchie*; Anmod, *Kapadia* 1877-1879 ; Castle Rock, *Kapadia* 2813.

Distribution : N. Kanara, Nilgiris, Pulneys, Malabar, Travancore.

Notes: We have collected this species in both dense and open forest, usually on *Mangifera* and *Artocarpus* trees ; the leaves of all the plants are of a deep purplish brown or brown colour with no sign of green. It is interesting to note that this species together with *O. bicornis* Lindl. and *O. tenuis* Lindl. are the only species found by us with brown leaves.

11. **Oberonia platycaulon** Wight, Icon. 5 (1) : 3, t. 1623, 1851 ; Lindl. 2 ; Hook. f. 628 ; Gammie 564 ; Cooke 677; Fischer 1407 ; Blatt. & McC. 257. *Malaxis platycaulon* (Wt.) Reichb. f. in Walp Ann. 6 : 239, 1861. *Iridorchis platycaulon* (Wt.) O. Kuntze, Rev. Gen. Pl. 2 : 699, 1891. (See Plate XV A-B).

Leaves 2-8 × 1-2 cm., ensiform, fleshy, oblong-lanceolate, acute. *Scape* arising from the central leaf, terete, bracteate. *Spike* 7 cm. long, about 0.5 cm. broad, somewhat curved. *Flowers* 3.5 × 1.5-2 mm., sessile, bracteate. *Bracts* 2 × 1.5 mm., oblong, ovate, acute, irregularly serrate, completely sheathing the ovary. *Sepals* 2 × 1.25 mm., subequal, acute or subobtuse, entire, 1-nerved, lying backwards along the ovary ; the dorsal one ovate, the laterals ovate-oblong. *Petals* 2 × 0.5 mm., reflexed along with the sepals, narrow-linear, subobtuse or acute, 1-nerved. *Lip* with the lateral lobes folded inwards, parallel along the column, 4 × 2 mm. when spread out, 3-lobed ; lateral lobes very broad, wing-like, 1.75 × 1.5 mm., oblong-orbicular, entire, wavy, longer than the midlobe ; midlobe somewhat quadrate, obscurely 3-lobed, truncate or rarely slightly retuse on the outer margin ; disc broadly oblong-orbicular, apiculate. *Column* 1 × 0.5 mm., oblong-subclavate, with an elliptic-orbicular stigmatic surface. *Anther* ovate, acute. *Ovary* 2 mm. long, sessile.

This species has been drawn and described from a specimen sent by Miss Evelyn Bowden from Travancore.

Occurrence in Bombay : This species is not definitely known to occur in the State. Hooker f. cites ' W. Ghats from the Konkan southwards ' ; Gammie lists it on the authority of Hooker f. ; Cooke has included it as doubtful in the State ; Blatter & McCann include it again on the authority of Hooker f. ; we have seen no specimens from Bombay.

Distribution : Konkan, W. Ghats (Mysore southwards). Nilgiris, Pulneys, High Wavy Mountains.

12. **Oberonia santapaui** Kapadia, nom. nov. *O. lindleyana* Wight, Icon. 5 (1) : 3, t. 1624, 1851 (non Brongn. ex Duperr. 1834) ; Lindl. 2 ; Hook. f. 681 ; Fischer 1406 ; Blatt. & McC. 258, t. 4. *Malaxis lindleyana* (Wt.) Reichb. f. in Walp. Ann. 6 : 210, 1861. *Iridorchis lindleyana* (Wt.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891.

We have seen no specimens of this species, and therefore give Wight's original description : ' Leaves ensiform, short, very succulent, slightly falcate ; stem compressed, spike drooping towards the apex, densely covered with innumerable small sessile flowers : bracts ovate, somewhat obtuse, sub-denticulate on the margin : sepals broad, ovate, obtuse entire : petals narrow linear : lip broad cordate at the base, crenate, two-lobed at the apex, with a minute tooth between ; all furnished with numerous minute opaque glandular (?) dots. Flowers straw colour, lip dull orange. Iyamally Hills near Coimbatore, flowering August and September. The leaves of this species are very succulent, and with its long drooping raceme afford good distinguishing marks, which are amply confirmed by an examination of the flowers. This species is remarkable on account of the opaque gland-like points scattered over the flowers. The bract is represented too pointed in the figure. I dedicate the species to the founder of the genus.'

Occurrence in Bombay: N. KANARA: In forests, *Bell*; Anmod *Sedgwick*.

Distribution : N. Kanara, Nilgiris, Travancore hills.

Notes : *Ind. Kew.* lists a binomial *Oberonia lindleyana* A. Brongn. in Duperr. Voy. Coq. Bot. 200, t. 40, f. a, 1834, (*O. lindleyi* on the figure). The binominal *O. lindleyana* Wt. (1851) is, therefore, a later homonym in the sense of the Code and must be rejected.

I name this species after Rev. Father H. Santapau under whose unfailing guidance and tremendous enthusiasm the study of the Orchids of Bombay has been undertaken. It is with the greatest pleasure that I dedicate the species to one of India's most distinguished botanists. (Z. Kapadia).

13. **Oberonia bicornis** Lindl. Gen. Sp. Orch. 16, 1830, et Fol. Orchid. Oberon. 4 ; Hook. f. 682. *Malaxis bicornis* (Lindl.) Reichb. f. in Walp. Ann. 6 : 211, 1861. *Iridorchis bicornis* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891. *Oberonia umbonata* Blatt. & McC. in J. Bombay nat. Hist. 35 : 259, 1931.

Pendulous brown *epiphytes*. *Leaves* 1-8 × 0.3-0.8 cm., brown or mauve-brown, narrowly linear-oblong or linear-lanceolate, often falcate, acute or acuminate, often surmounted with a bristle. *Scape* 2-10 cm. long, brownish ; bracts 2 mm. long, sharp, bristle-like. *Inflorescence* 1.5-12 cm. long, straight or bent in the upper third. *Flowers* up to 2 mm. long in dense or lax verticils or subverticils, ochraceous-red, pedicellate, bracteate. *Bracts* 0.66-2 mm. long, usually longer than the flowers, lanceolate from a broad base, with a sharp, long acumen, or oblong, sharply acuminate, bristle-pointed, hyaline, gland-dotted. *Sepals* equal or subequal, pale ochraceous, 1-nerved, hyaline, gland-dotted ; the dorsal one more or less equal to the lateral sepals, convex, ovate or ovate-lanceolate or oblong-ovate, acute-mucronulate or obtuse with a minute sharp acumen ; lateral sepals convex, ovate-orbicular, mucronulate. *Petals* ochraceous, about equalling the lateral lobes of the lip, oblong-subtriangular or linear-oblong or narrowly obspathulate, subobtuse or acute, entire or very minutely serrulate, 1-nerved, hyaline, gland-dotted. *Lip* deep red, 3-lobed ; the width across the lateral lobes more or less equal to that across the midlobe ; lateral lobes erect, linear-lanceolate, coriaceous, surrounding the column, slightly incurved towards the apices ; midlobe of lip curving upwards along with the lateral lobes in flower ; the basal margin obscurely 3-lobed ; apex straight or pointing downwards, acute or obtuse-mucronulate. *Column* broad. *Anther* brownish white, transversely oblong-orbicular, mucronulate. *Ovary* with pedicel nearly 2 mm. long. *Capsule* 2.5 × 1.50 mm., pedicellate, nearly spherical ; stalk 1.2 mm. long.

Flowering and *Fruiting* : October to November.

Occurrence in Bombay: N. KANARA: Siddhapur, *Kapadia* 2389-2395 ; Siddhapur to Sirsi, *Hallberg & McCann* 35177.

Distribution : *India* : Khasia Hills, N. Kanara. *World* : India, Ceylon.

Notes : We found this species epiphytic on *Memecylon* sp.

After careful study of fresh flowers from Siddhapur (the type locality of *O. umbonata* Blatt. & McC.) we conclude that the latter is identical with *O. bicornis* Lindl. *O. bicornis* Lindl. is similar to *O. tenuis* Lindl., from which it can be distinguished by the former having (1) petals which are broadly ovate or obspathulate ; (2) lateral lobes of lip which are linear-lanceolate, erect, not filiform and incurved ; (3) midlobe of lip which is fleshy, cuneate, truncate or minutely apiculate, not broadly 3-lobed with the ends much prolonged.

14. **Oberonia tenuis** Lindl. Fol. Orchid. Oberon. 3, 1852 ; Hook. f. Icon. Pl. t. 1779 B, 1888, et Fl. Brit. Ind. 5 : 682, 1890. *Malaxis tenuis* (Lindl.) Reichb. f. in Walp. Ann. 6 : 211, 1861. *Iridorchis tenuis* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891.

Pendulous brown *epiphytes*. *Leaves* 0.6-6 × 0.3-0.6 cm., brown, linear or linear-lanceolate, subfalcate or ovate-oblong, acute or acuminate, often bristle-pointed. *Scape* terete, yellowish brown, 2-5 cm. long, with spreading, hyaline, subulate bracts. *Inflorescence* 1.5-12 cm. long, squarrose, more or less straight. *Flowers* brownish red, bracteate. *Bracts* oblong-lanceolate to linear-lanceolate, subulate, acute or acuminate, entire, gland-dotted. *Sepals* subequal, gland-dotted, concave ; the dorsal sepal is narrow-lanceolate, at times ovate-lanceolate or ovate-oblong, hardly bigger than the lateral sepals, acute or subacuminate ; the lateral ones orbicular or orbicular-ovate, mucronulate. *Petals* narrow, linear, acute or subobtuse, gland-dotted, faintly 1-nerved. *Lip* 3-lobed ; lateral lobes erect, surrounding the column and meeting above it, narrowly filiform, aristate, shorter than the petals ; midlobe dextrously folded upwards along the lateral lobes, lunate, the tips much-prolonged, acuminate ; the midlobe obscurely or not at all 3-lobed on the basal margin. *Column* short. *Ovary* 1 mm. long, rarely slightly curved at the base. *Capsule* brown, strongly ribbed, orbicular or oblong-orbicular, with an equally long stalk.

Flowering and *Fruiting* : March.

Occurrence in Bombay : N. KANARA : Castle Rock, *Kapadia* 2821.

Distribution : *India* : N. Kanara. This species has been recorded for Bombay State and India for the first time ; up to now known only from Ceylon. *World*: India, Ceylon.

Notes : Hooker f. describes the leaves as linear-oblong, the lip with very small, hatchet-shaped midlobe and linear erect incurved sidelobes that form a circle round the ovary. In our specimen the leaves are linear-oblong, acuminate, often bristle-pointed, and the lateral lobes of the lip form a circle round the column (and not round the ovary as stated by Hooker f.) ; the midlobe is narrowly lunate with much-prolonged acuminate tips.

15. **Oberonia** sp. Large pendulous *epiphytes*. Leaves thin, oblong-lanceolate, up to 17 × 1.5 cm. *Inflorescence* arising directly from a narrowly linear, leaf-like peduncle. *Flowers* long-pedicelled, minute, densely imbricating, often in more or less distinct whorls. The flowers are too old and decayed for careful analysis.

Flowering : probably about September to October.

Occurrence in Bombay State : N. KANARA : Jog, *V. Patel* 1915 ; *Kapadia* 2425-2427.

Notes: This seems to be quite a distinct species, very unlike any of those discussed above ; scarcity of materials prevents us from a definite identification.

We found these plants to be fairly common along the way to the ferry, from the Bombay side of Jog falls.

Imperfectly known Species

16. **Oberonia bellii** Blatt. & McC. in J. Bombay nat. Hist. Soc. 35 : 256, f. 1. 1931.

This species was described and illustrated from Bell's manuscript notes ; no actual specimens were examined by the authors. We have not been able to locate it in Bombay.

The following is Blatter & McCann's original description :

' Pertains to section *Oberonia* proper. Approaching *Oberonia verticillata*, but differing in the 8-grooved rachis, bracts lanceolate, imbricate, slightly longer than the buds, flowers sessile, petals ovate-oblong, lip oblong, midlobe bifid erose ligulate, segments obliquely truncate at the apex.

' *Scape* together with raceme almost twice as long as longest leaf. *Leaves* narrow, ensiform, falcate or subfalcate, acuminate, broad at base, up to 10 × 1 cm. *Rachis* fairly stout with 8 grooves, and 8 rounded ridges between the grooves. *Buds* globose, apiculate. *Flowers* sessile, 2 mm. long, verticillate, one flower on each ridge, the ridge of one node being continued by a groove on the next. Internodes 2.5 mm. long. *Bracts* 2 mm. long, lanceolate, acute, membranous, broadest in the middle, fimbriate, slightly longer than the buds. *Sepals* ovate-acute, subequal. *Petals* narrower than the sepals, erose ; side lobes very small, rounded ; midlobe bifid with strap-shaped slightly divergent obliquely truncate segments ; sinus 1/3 of the whole lobe. *Ovary* 1 mm. long. *Column* merely a horse-shoe-shaped low wall, covered by a nearly circular, lowly convex, green, smooth little cap. *Pollinia* extremely minute, orange-yellow, pear-shaped ; point of attachment short and pointed (fixed to a minute surface at each end of horseshoe rim of column).

' The pollinia fall out when the flower is ready, the cap raising itself for the purpose. The hollow in the form of the column is square. (Bell).'

Flowering : March.

Occurrence in Bombay : N. KANARA : Yellapur, *Bell.*

Notes: There seems to be hardly any difference between this species and *O. verticillata* Wt., but absence of the type prevents us from attempting a definite identification.

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Butterflies of the Palni Hills: a Complementary List

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With a view to supplement the list of butterflies of the Palni Hills made by Evans (1910), the authors explored the entire Palni range at all elevations and at all seasons of the year over a period of ten years. This paper gives a list of 54 new recordings made in the course of the work.

Before we present our fresh data on the butterflies of the Palnis, a few lines on these hills and on the significance of our list may prove useful.

The Palnis (Madurai Dt., S. India) run parallel to and south of the Nilgiris. About 70 miles (110 km.) long and of an average breadth of some 15 miles (24 km.), they abut against the Western Ghats, rising gradually east-west up to a high tableland of 8000 ft. (2400 m.), 30 miles (48 km.) long, with Kodaikanal at 7000 ft. (2100 m.) The variety and abundance of the butterfly fauna of these hills vary obviously with the richness and kinds of vegetation. Without going into details about the latter, we may note in general that while the northern and southern slopes and valleys show great floral or forest luxuriance, the upper plateau west of Kodaikanal consists mainly of grasslands interspersed with some sholas. The eastern lower Palnis up to 4500 ft. (1400 m.) on the other hand cover large cultivated areas of plantains, oranges, lemon, coffee, cardamom, etc.

Taking this into account, we mention below a few places of particular interest to butterfly collectors :

(1) The Tope, 1000 ft., (300 m.) and Vengayaparai, 2300 ft. (700 m.) at the 5th and 8th mile respectively of the ' Old Coolie Road ' from Peryakulam Town to Kodaikanal ;

(2) Thalayar Falls, 3000 ft. (900 m.), facing the 8th mile of the Motor Road, which links Kodaikanal Hill Station to the Kodaikanal Road-Peryakulam highway ;

(3) Perumal-Neutral Saddle, 5000 ft. (1515 m.), and Sacred Heart College, Shembaganur, 6000 ft. (1820 m.), at the 23rd and 27th mile on the Motor Road respectively ;

(4) Palar Dam, 4000 ft. (1210 m.), on the 7th-12th mile of the Coolie Path from Neutral Saddle to Palni Town ;
(5) Porandalar Valley, 3500 ft. (1160 m.), below Palanghi village ;
(6) Manalur, 3300 ft. (1000 m.), in the Lower Palnis ;
(7) Manjampatti-Tallungi 2200 ft. (670 m.), some 7 to 12 miles (11km. to 19 km.) up the Amaravati Dam.

Since Evans listed the butterfly fauna of the Palnis in 1910, little has been done as far as we are aware to confirm and complete his findings in this region. The advisability of a fresh survey was suggested by his own statement, in his article on the Palni Butterflies, that probably ' another 100 species ' could easily be added to his recordings. It is this which impelled us, as permanent residents of these hills, to start working on our ' Complementary List '. As we were working on Evans's List of Palni Butterflies we have followed his nomenclature.

Whereas Evans collected mainly at the Tope or around Kodaikanal and this too for only 6 weeks (end of Aug. to early Oct.) supplementing his findings from other reliable sources, we have tried to explore the entire Palni Range, at all elevations and seasons of the year, over a period of some 10 years. While covering all the Palnis, however, our List lays a heavy emphasis on the Tope-Vengayaparai region ; for any one familiar with these hills will agree that this region, as Evans has also pointed out, still gives the best yield in both varieties and numbers of butterflies.

Our study has been carried out mostly with the help of the clerical (Jesuit) students of Sacred Heart College, Shembaganur. But we must also gratefully mention the valuable collaboration of the boys of Highclerc School, Kodaikanal, and of Mr. Alan Sharman of Madras.

Thanks to these combined efforts, we have been able to gather over 250 kinds of Heterocera and 228 species of Rhopalocera. Taking only the latter into account, we would like to note the following with reference to Evans (1910) :

(*a*) Our observations confirm 174 of Evans (1910) recordings ; though occasionally with not a few divergent data regarding location, elevation, and seasonal appearance of large numbers ;

(*b*) We have not as yet recorded 17 of Evans's listing in 1910. Of these, three appear on all accounts to belong to the Palnis, namely *Telicota concinna*, *Telicota gola*, and *Castalius ananda*. As for the remaining 14, recent taxonomic regroupings and modifications in nomenclature make it extremely difficult to say anything definite ;

(*c*) The few discrepancies between our findings and those of Evans may, to a large extent, be explained by the fact that the Palnis are not quite the same today as Evans knew them 50 years ago. For with ruthless cutting down of forests, species once apparently abundant have now become quite rare, not to say extinct ;

(*d*) In spite of this deforestation, our survey has given us 54 new records, not as yet the 100 predicted by Evans ! They are listed below, but it would be difficult in some cases to state exactly whether we are dealing with permanent or only migratory forms of the Palnis.

LIST OF NEW RECORDS

HESPERIIDAE

1. **Astycus pythias lanka** Evans

Two at Vengayaparai in Sept.-Oct. One at the 7½ mile of the Coolie Road in July.

2. **Baoris conjuncta narooa** (Moore)

Several at all elevations.

3. **Baoris guttatus bada** (Moore)

Two at Palar Dam in Feb.

4. **Bibasis sena** (Moore)

Three at Vengayaparai, one at the Tope in Feb., one at the 7½ mile of the Coolie Road in Nov.

5. **Caprona ransonnetti lanka** Evans

Common at lower elevations all through the year, more abundant at higher elevations in Feb.-Mar.

6. **Caprona ransonnetti taylorii** (de Nicéville)

At lower elevations all through the year, especially at Vengayaparai.

7. **Daimio bhagava bhagava** (Moore)

One at Porandalar Valley in July.

8. **Gangara thyrsis thyrsis** (Fabricius)

One taken by Highclerc students, one mile above the Palar Dam site in May.

9. **Hasora taminatus taminatus** Hübner

Not rare at Vengayaparai and at higher elevations in Aug.-Sept. A few stray ones may be taken at higher elevations in Nov.

10. **Ismene jaina fergussoni** de Nicéville

One at Vengayaparai along the stream in Nov. One ♂ caught and another ♂ seen by Mr. Sharman by the tope stream in March.

11. **Matapa aria** (Moore)

Not rare at higher elevations in July-Oct.

12. **Padraona cato** Evans

Common at Vengayaparai in Aug.-Sept.

LYCAENIDAE

13. **Amblypodia amantes amantes** Hewitson

Several along the stream from the Tope to Vengayaparai at all seasons, chiefly Aug.-Feb.

14. **Amblypodia centaurus pirama** (Moore)

Less common than *amantes*, though found in the same locality. A ♀ was taken by Mr. Sharman at the Tope stream in May also, four ♂♂ and three ♀♀ in July and many others both sexes seen.

15. **Bindahara phocides moorei** Frühstorfer

One ♂ and one ♀ at the 7½ mile of the Coolie Path along the stream at Palar Dam in July. Two ♂♂ were taken by Mr. Sharman at the Tope stream in March ; also, one ♀ seen at Vengayaparai in July. One ♂ at milestone 5/2 of the Motor Road in July.

16. **Charana jalindra** (Horsfield)

One ♂ at Shembaganur in Jan.

17. **Deudoryx epijarbas** (Moore)

Two ♂♂ taken at mile 6 and 7½ of the Old Coolie Road, along the stream, in Sept.

18. **Everes parrhasius** (Fabricius)

Common at all elevations all the year round.

19. **Horaga onyx** (Moore)

One in Sacred Heart College Museum, Shembaganur, but without exact records as to its location and season.

20. **Iraota timoleon arsaces** Frühstorfer

Several ♂♂ and ♀♀ were taken at 7½ mile of the Old Coolie Road, along the stream, in Sept. and May. Five ♀♀ taken by Mr. Sharman along the Tope stream in May ; also, one ♂ and three ♀♀ in July and several both sexes seen.

21. **Nacaduba beroe gythion** Frühstorfer

Two at Vengayaparai stream in Sept.

22. **Nacaduba dubiosa indica** Evans

Common along the stream from the Tope to Vengayaparai all through the year.

23. **Nacaduba helicon viola** (Moore)

Three ♂♂ and two ♀♀ at Vengayaparai in Aug.-Sept. and Apr.-June. One ♂ at mile 5/2 of the Motor Road in July.

24. **Nacaduba hermus nabo** Frühstorfer

Two ♂♂ and two ♀♀ between the 22nd and 23rd mile of the Motor Road in Oct.

25. **Nacaduba kurava canaraica** (Moore)

One ♂ and one ♀ in the same location as *nabo.*

26. **Pratapa deva deva** (Moore)

One ♀ in Shembaganur in Dec.

27. **Rapala melampus** (Cramer)

One ♂ taken by Highclerc students at Kodaikanal in Feb.

28. **Rapala schistacea** (Moore)

Not rare at the Tope stream, the ♂ being more common. Several ♂♂ and ♀♀ were taken at mile 5/2 of the Motor Road in July.

29. **Spindasis elima elima** (Moore)

Two ♂♂ taken by Mr. Sharman at the Tope in May.

30. **Spindasis ictis ictis** (Hewitson)

One ♂ in Sacred Heart College Museum, Shembaganur, but without exact records as to its location and season.

31. **Spindasis schistacea** (Moore)

Some ♂♂ at mile 5/2 (The Temple) of the Coolie Road in Sept. and Feb. One ♂ taken in Shembaganur in Feb.

32. **Tajuria cippus cippus** (Fabricius)

Several ♂♂ and ♀♀ at the Tope stream in July. ♂♂ were taken a few months later too.

33. **Tajuria melastigma** de Nicéville

One ♀ taken at the Tope by Mr. Sharman in May. One by us in July.

34. **Tarucus nara** (Kollar)

One ♂ and one ♀ at Palar Dam in Oct.

35. **Virachola isocrates** (Fabricius)

One ♂ at Manalur in Jan. Two ♀♀ at the Tope and Kodaikanal respectively in Feb.

36. **Zesius chrysomallus** (Hübner)

Two ♀♀ along the stream between the 5th and 6th mile of the Old Coolie Road, in Jan.

37. **Zizeeria trochilus putli** (Kollar)

Common at all elevations all through the year.

NYMPHALIDAE

38. **Biblia ilythia** (Drury)

Given by Evans 1910 for the plains (Peryakulam). One was taken in Shembaganur and another at the Tope in Sept.

39. **Cethosia nietneri mahratta** Moore

One ♀ at Vengayaparai in June.

40. **Doleschallia bisaltide malabarica** Frühstorfer

One at Shembaganur in Nov.

41. **Euthalia evelina laudabilis** Swinhoe

One ♂ and one ♀ at Vengayaparai and Thalayar Falls respectively, in Sept.-Oct. One ♂ at the Tope in July.

42. **Euthalia lubentina arasada** Frühstorfer

One ♂ taken at Vengayaparai and another along the stream at mile 6 of the Old Coolie Road in Oct. One ♀ seen at mile 19/3 of the Motor Road in Oct.

43. **Pantoporia selenophora kanara** Evans

One ♂ taken at Kodaikanal in Jan. and another at mile 20 of the Motor Road in March. One ♀ at Neutral Saddle in Sept.

44. **Precis atlites** (Linnaeus)

Several at Talungi in April.

PAPILIONIDAE

45. **Chilasa clytia clytia** (Linnaeus)

One ♂ at Neutral Saddle in May and another at Vengayaparai in Oct.

46. **Chilasa clytia dissimilis** (Linnaeus)

One ♂ taken a mile and a half after Palar Dam in June and another at mile 9 of the Old Coolie Road in Nov.

47. **Papilio paris tamilana** Moore

Several at Manalur in April. One was taken at Kodaikanal by the students of Highclerc in Sept.

48. **Pathysa nomius nomius** (Esper)

Several at Manjampatti in April and at the foot of Thalayar Falls in Oct.-Nov. A few were taken at the Tope in Oct. and Jan.

PIERIDAE

49. **Appias lyncida latifasciata** Moore

One ♂ at the Tope in Dec. One ♀ in Sacred Heart College Museum, but without records as to its location and season.

50. **Appias paulina wardii** (Moore)

Two ♂♂ and two ♀♀ at the Tope and Shembaganur in March and Nov. respectively.

51. **Catopsilia pomona** (Fabricius)

Very common at all elevations all the year round. Abundant in Kodaikanal in Dec.-Jan.

52. **Catopsilia pomona** var. **catilla** (Cramer)

Less common than the previous.

53. **Huphina nadina remba** (Moore)

One ♂ taken and another seen by Mr. Sharman at the Tope in May.

54. **Terias andersoni ormistoni** Watkins

Common at all elevations all through the year.

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[In addition to the new records from the Palnis mentioned above, Mr. A. J. Sharman adds the following :

HESPERIIDAE

1. **Tapena thwaitesi hampsoni** Elwes & Edwards.

One ♂ along the Tope stream in July.

LYCAENIDAE

2. **Pratapa cleobis** (Godart)

One ♀ in the Perumal Reserve Forest in May. [Fr. Ugarte also reports that since the paper was submitted the authors caught one ♂ of this species at the Motor Road milestone 19 in October.]

3. **Amblypodia abseus** Hewitson

One seen by the Tope stream in July.

—Eds.]

The Birds of Nepal

BY

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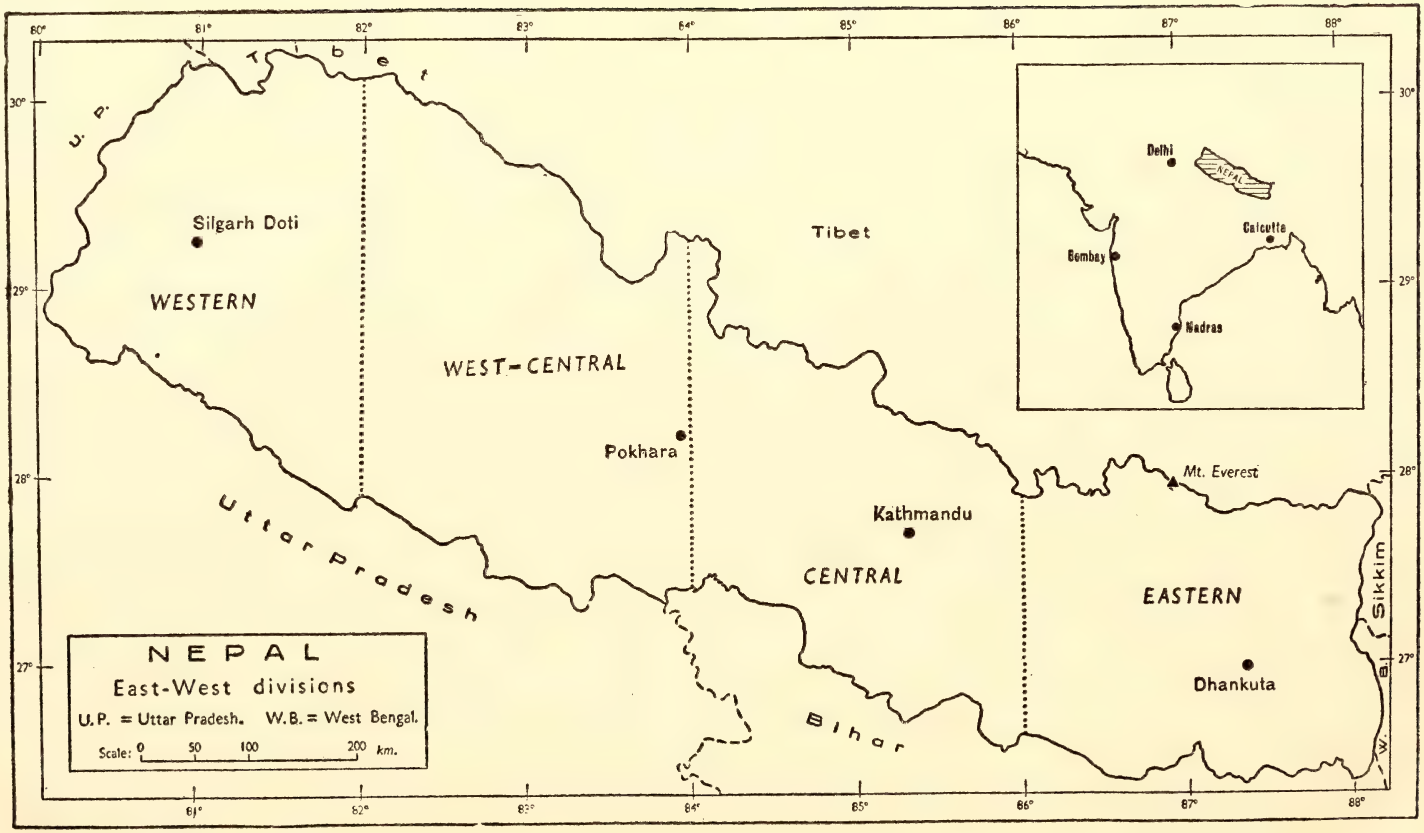
(*With a map*)

INTRODUCTION

Snug in the heart of the majestic grandeur of the Himalayas lies the little kingdom of Nepal—the naturalists' dreamland. The country spreads over a length of some 800 kilometres covering parts of both the western and the eastern Himalayas. The average breadth is merely 150 km. or so. Nevertheless, within this limited space one may travel from the Oriental Region to the Palaearctic—from flat alluvial plains to the highest points on earth, from hot steamy tropical valleys filled with luxuriant and almost impenetrable rain forests to the treeless, eerie wilderness of eternal snows, from bare rocky wastes to lush alpine meadows with their celestial floral carpets, let alone the crags and cliffs and other features which combine Nature's tenderest beauties with her most savage grandeur. Mountain-bound placid lakes, age-old untrodden glaciers, murmuring brooks, rippling rivulets, thundering waterfalls, tumultuous torrents winding through precipitous gorges of terrifying aspect, and great rivers carrying enormous quantities of water and debris to the plains present wide and complex differences in the landscape. Such a country of diverse contrasts shelters, as may be expected, a unique fauna, of which birds constitute the richest group both in number and in variety of forms.

Here in Nepal the indomitable British Resident Brian Hodgson, aptly called ' the father of Indian vertebrate zoology ', laid the foundation of the study of Indian vertebrates during the third decade of the nineteenth century, making avifauna his first choice. Since then the birds of Nepal continued to dominate the field of Indian ornithology until a number of additional bird students appeared on the scene to spread the focus to the less inaccessible parts of the country. The subsequent history of the ornithology of Nepal has been briefly summarized by Ripley (1950b) and by Rand & Fleming (1957).

In 1947, the present author who was then under training in Systematic Zoology at the Zoological Survey of India, had the opportunity to spend


80°
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Tibet
U. P.
Silgarh Doti
WESTERN
WEST-CENTRAL
Pokhara
Kathmandu
CENTRAL
Mt. Everest
EASTERN
Dhankuta
Sikkim
W. B.
Uttar Pradesh
Bihar
Delhi
NEPAL
Bombay
Calcutta
Madras
NEPAL
East-West divisions
U.P. = Uttar Pradesh. W.B. = West Bengal.
Scale: 0 50 100 200 km.

Nepal, showing east-west divisions, viz. western, west-central, central, and eastern.

four months (March-June) in field work in Nepal, mainly ornithological study and collecting. This project was undertaken in co-operation with Dr. Walter Koelz, an American private collector of great experience. Dr. Koelz spent a little over five months (from March till early August) in Nepal. Those were the days when Nepal was still virtually closed to foreigners, so that our area of operation had to be restricted to the strip of country along the main road to Kathmandu from Raxaul in north Bihar, India, and to within 15 miles radius of Kathmandu. In spite of this limitation and of the season (the very heavy Himalayan monsoon from late May), the collection of birds made by the joint team totalled about 3500 specimens representing some 350 species and subspecies.

The birds of Nepal have great significance for Indian ornithology, mainly since this was the first area in the Indian Region to be explored on a large scale, and it is the type locality of nearly 10% of currently accepted forms of Indian birds.

In this paper the author has not only presented the data of the Koelz-Biswas collection, but has also attempted to give a complete list of birds known from Nepal so far, together with such information on the occurrence of each form as is available in the published literature. The species and subspecies have been serially numbered, and arranged in taxonomic sequence following Mayr & Amadon (1951), Biswas (1953), Mayr & Greenway (1956), and Vaurie (1959a). Forms whose occurrence in Nepal is doubtful, have not been given any serial number, but have been recorded in square brackets at the appropriate places in the sequence. Forms that were not found by the Koelz-Biswas team have been indicated by asterisks preceding the serial numbers. Since the original references to the various names are all available in standard books, they have been left out generally. However, wherever discrepancies have been noticed between the originals and those given in the standard literature, or whenever necessary for discussion, they have been retained.

It is proposed to include notes on the physiography, biotope, etc. of our collecting areas, and on the zoogeography of Nepal in the last instalment of this paper. For the present, however, the following explanation of the physiographical expressions used in the paper is given :

PLAINS—comprising the southernmost strip of flat plains indistinguishable from the plains of northern India adjoining Nepal. Heavily cultivated. Altitude up to about 150 m.

TARAI—comprising a belt north of the plains and consisting typically of thick forest interspersed with a large number of slow rivers. A great part of the tarai is cultivated at present. Altitude about the same as the plains.

BHABAR—comprising the strip from the edge of the tarai up to the Siwalik Hills. It is a heavily forested land (Sāl forest zone of Hodgson and of Scully) sloping southward. Altitude *c.* 150-300 m.

DUN—consisting of the zone of east-west valleys situated between the Siwaliks and the main Himalayan foothills. Heavily forested and interspersed with cultivation near scattered villages. Altitude *c*. 300-1370 m.

HIGHER RANGES—comprising the Himalayas proper. Heavily forested up to about 2740 m., but with extensive terraced cultivation near human habitation. Altitude over 1370 m.

In central Nepal the ' higher ranges ' zone has been further subdivided into :

(a) *Markhu Valley*—situated between the Mahabharat Range on the south and the Chandragiri on the north,

(b) *Chitlang Valley*—situated immediately to the south of the Chandragiri, and

(c) *Nepal Valley*—comprising the almost enclosed valley in which Kathmandu is situated. This valley has also been sometimes referred to simply as the Valley.

Various other places have been referred to according to the valleys in which they are situated.

For the sake of convenience of reference in this paper, Nepal has also been divided east-west into four areas (see Map), namely :

WESTERN—consisting of the part of the country from its extreme western border eastward up to long. 82°E.

WEST-CENTRAL—from long. 82°E. up to 84°E.

CENTRAL—from long. 84°E. up to 86°E.

EASTERN—from long. 86°E. to the extreme eastern edge of the country.

For the spellings of various geographical names, Survey of India maps have been generally followed.

ACKNOWLEDGEMENTS

I am thankful to the Government of Nepal for permitting us to make an ornithological collection there and for granting us all facilities in that connexion. My thanks are also due to the Government of India for bearing the major portion of the expenses of my study tour by awarding me an Overseas Scholarship. To three American friends who prefer to remain anonymous I am particularly indebted for providing me, through the American Museum of Natural History, with a scholarship that enabled me to carry on with my work during my last three months' stay in the U.S.A.

The authorities of the British Museum (Natural History) and the American Museum of Natural History, especially the staff of their ornithological departments, have been most helpful to me not only during the period I worked there, but even today, and I hereby tender them my grate-

ful appreciation. My thanks are also due to Dr. Walter Koelz for very kindly allowing me to work out his collection, and to the Bombay Natural History Society for lending comparative study material whenever it was needed.

I have been fortunate in receiving help in various ways from a large number of persons, among whom I must mention Dr. Sálim Ali, Dr. Dean Amadon, Professor J. L. Bhaduri, Mr. H. G. Deignan, Mr. J. Delacour, Mr. D. Goodwin, the late Capt. C. H. B. Grant, the late Dr. S. L. Hora, Mr. J. D. Macdonald, Mr. Daniel Marien, the late Mr. P. N. Mitra (who was my companion in Nepal), Mr. B. Roy, Mr. H. B. Usher, and Dr. Charles Vaurie.

I would be failing in my duty if I did not express my debt of deep gratitude to Professor Ernst Mayr who has not only rendered me constant inspiring guidance throughout this work, but also spent many hours of his extremely congested time in discussing various items, in reading through the manuscript, and helping me in other ways.

A complete list of references will be given at the end of this paper. Only a reference to some of the publications on Nepal ornithology cited frequently in the following pages is considered of relevance at this stage :

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NOTE. In the Systematic List that follows

1. Forms that were not found by the Koelz-Biswas team have been indicated by asterisks preceding the serial numbers.
2. Forms whose occurrence in Nepal is doubtful have not been given any serial number, but have been recorded in square brackets at the appropriate places in the sequence.
3. All measurements are in millimetres. The wing and tail have been measured in the standard way. Unless otherwise stated, the bill size refers to the measurement in a straight line from the base of the bill on the skull to its tip. Numerical frequencies of measurements occurring more than once are given in parentheses.

SYSTEMATIC LIST OF BIRDS

Order PODICIPIFORMES

Family PODICIPEDIDAE

*1. **Podiceps ruficollis capensis** Salvadori. Indian Little Grebe.

The Indian Little Grebe was not found by us or by Rand & Fleming (1957), but Scully (1879, p. 364) found it to be tolerably common in the Nepal Valley between early September and mid-May, and Ripley (1950b, p. 363) noted it in the lower tarai near the Indian border.

*2. **Podiceps nigricollis nigricollis** C. L. Brehm. Blacknecked Grebe.

The Blacknecked Grebe was reported for the first time from Nepal by Rand & Fleming (1957, p. 48) who obtained a single specimen in west-central Nepal (Pokhara). Since then it has not been recorded from Nepal.

In view of the ruling on Opinion 406 (*Opin. int. Com. zool. Nom.*, 1956, **13** : 120) Brehm's name *Podiceps nigricollis*, 1831, must be retained for this species in preference to Hablizl's *Podiceps caspicus*, 1783.

*3. **Podiceps cristatus cristatus** (Linnaeus). Great Crested Grebe.

We were unable to find the Great Crested Grebe in Nepal, neither were Scully (1879) and Ripley (1950b), but Rand & Fleming (1957, p. 48) obtained three specimens in December and February in west-central Nepal (Pokhara), the only ones from that country since Hodgson's days.

Order PELECANIFORMES

Family PHALACROCORACIDAE

*4. **Phalacrocorax carbo sinensis** (Shaw). Large Cormorant.

The Large Cormorant was not seen by us in Nepal, or by Rand & Fleming (1957), but Scully (1879, p. 364) reported it from Trisul Ganga river, Nawakot district, central Nepal, in November, and Ripley (1950b, p. 363) found it on Karnali River in the dun of western Nepal early in January.

*5. **Phalacrocorax niger** (Vieillot). Little Cormorant.

Hodgson's collection (Gray & Gray, 1846, p. 149) provides the sole record of the occurrence of the Little Cormorant in Nepal.

*6. **Anhinga rufa melanogaster** Pennant. Darter.

The Darter was not obtained by us, but Scully (1879, p. 364) found it in the central bhabar in December, Ripley (1950b, p. 363) in small ponds in the tarai, Rand & Fleming (1957, p. 48) in the western tarai in November. Proud (1955, p. 72) once saw a storm-driven example soaring over the Nepal Valley in April.

Family PELECANIDAE

*7. **Pelecanus philippensis philippensis** Gmelin. Spottedbilled Pelican.

The only record of the pelican from Nepal is provided by Hodgson's collection (Gray & Gray, 1846, pp. 148-149).

Order FALCONIFORMES

Family ACCIPITRIDAE

*8. **Elanus caeruleus caeruleus** (Desfontaines). Blackwinged Kite.

The Blackwinged Kite was not found by us or by Scully (1879) in Nepal. However, it was recorded by Ripley (1950b, p. 364) to be common in the tarai along the edges of forests, and by Rand & Fleming (1957, p. 52) as common in the lowlands of eastern and western Nepal in winter. Proud (1952b, p. 669) once saw it in the Nepal Valley in June. Biswas (1960a) reports it from *c.* 1370 m. in Chautara district, central Nepal, on January 31.

*9. **Aviceda leuphotes** (Dumont)[1]. Blackcrested Baza.

This baza was not found by us in Nepal, nor does it seem to have been recorded from that country since Hodgson's days.

10. **Pernis ptilorhynchus ruficollis** Lesson. Indian Crested Honey Buzzard.

TARAI : Simra : 1 subad. ♂ (March 5). DUN : Hitaura : 2 ♀♀ (July 20, 26).

The Crested Honey Buzzard was seen by us only in the tarai and dun of central Nepal, but Proud (1955, p. 71) found it to be common in the Nepal Valley from November to March. She also observed it in west-central Nepal. Scully (1879), Ripley (1950b), and Rand & Fleming (1957) did not record it from Nepal.

One of my female specimens (July 20) has the head and nape almost white with black shaft stripes, under plumage white with black shaft stripes on chin and throat, black central streaks (rather black drops) on breast and abdomen, fewer on the latter.

Measurements : 2 ♀♀ : Wing 408,—; tail 264, 270 ; bill 40 (2) ; culmen from the edge of cere 22.5, 23.

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[1] One of the two specimens obtained by Shri Gobind Bahadur Gurung at Bijaipur about 30 miles north of Biratnagar in eastern Nepal on 22 April 1959 for Klavs Becker-Larsen of Copenhagen is in the Society's collection.—EDS.

11. **Milvus migrans govinda** Sykes. Pariah Kite.

Although observed in the plains and tarai in March, no specimen of the Pariah Kite was obtained by us in Nepal. Ripley (1950b) did not find it in Nepal. Rand & Fleming (1957, p. 52) reported it from the lowlands. Biswas (1960a) found it up to *c.* 1520 m. in eastern Nepal. Some of Scully's (1879, pp. 227-229) specimens of the species, entered under three different names, undoubtedly represent this form.

12. **Milvus (migrans) lineatus** (J. E. Gray). Large Indian Kite.

Dun : Hitaura : 1 ♀, 1 subad. unsexed (May 14, June 2). Mahabharat Range : Chisapani Garhi : 1 ♀ (July 26). Chitlang Valley : Chitlang : 1 subad. ♀ (April 21). Nepal Valley : Kathmandu : 1 ♂ (April 6).

The Large Indian Kite is a common bird in central Nepal from the dun to the Valley. Lowndes (1955, p. 36) saw a pair at *c.* 3500 m. in Manangbhot, central Nepal, in July, and Biswas (1960a) collected it at *c.* 4260 m. and observed it once even at *c.* 5330 m. in Khumbu, eastern Nepal, in May.

My male specimen from Kathmandu (April 6) had somewhat swollen testes, and the female from Hitaura (June 2) had a shrunken ovary.

The Chisapani Garhi specimen has an additional abnormal structure on its bill, as has already been reported (Biswas, 1956).

Colours of soft parts : Iris dark brown, bill black with bluish slaty on base, cere pale yellow with bluish slaty on base, legs and feet dull bluish white, claws black, pads white.

Measurements :

	Wing	Tail	Bill	Culmen from the edge of cere
1 ♂ :	490	315	39	30
2 ♀♀ :	496, 498	307+, —	39, 41	29, —

13. **Haliastur indus indus** (Boddaert). Brahminy Kite.

Dun : Hitaura : 1 subad. ♀ (May 30).

During spring and summer, a few examples of the Brahminy Kite were found by us in the dun usually near streams, but none in the Nepal Valley. Scully (1879, p. 227) found it in the plains and tarai of central Nepal as a resident bird, and in the Nepal Valley in March, August, and September as a straggler. Proud (1949, p. 717), on the other hand, noted it to be a late summer (August-September) visitor to the Valley. Rand & Fleming (1957, p. 53) found it to be the common kite of the lowlands in winter. Biswas (1960a) reported it from the Pilua Khola Valley, eastern Nepal, at *c.* 1370 m. in June. Ripley (1950b) did not include it in his list.

*14. **Accipiter gentilis schvedowi** (Menzbier). Goshawk.

After Hodgson's collection the only record of the Goshawk from

Nepal is furnished by Scully (1879, p. 223) who did not obtain any specimen but found it to be a rare straggler to the Nepal Valley in winter.

15. **Accipiter badius dussumieri** (Temminck). Indian Shikra.

DUN : Hitaura : 3 ♂♂, 1 juv. ♂, 1 ♀ (May 30—June 16).

In central Nepal the Shikra appears to be fairly common in the dun, but rather scarce in the Nepal Valley.

Measurements :

	Wing	Tail	Bill	Culmen from the edge of cere
3 ♂♂ :	179, 180, 183	134, 139, 140	20 (2), 21	12.5, 13, 13.5
1 ♀ :	214	170	22	15

*16. **Accipiter trivirgatus indicus** (Hodgson). Northern Crested Goshawk

This goshawk was not obtained by us or by Scully (1879) in Nepal, but Ripley (1950b, p. 365) collected a single example in the eastern tarai in February, and Rand & Fleming (1957, p. 53) had a single specimen from west-central Nepal in December.

17. **Accipiter nisus nisosimilis** (Tickell). Asiatic Sparrow-Hawk.

DUN : Bhimphedi : 1 ♂ (March 12). NEPAL VALLEY : Kathmandu : 1 ♀ (March 24).

This sparrow-hawk was seen by us on several occasions in March chasing small birds in the outskirts of Kathmandu and about the villages on the Bhimphedi-Thankot trail. Proud (1949, p. 718) found it as a common winter visitor in the Nepal Valley, and Rand & Fleming (1957, p. 53) occasionally saw it in the lower hills (*c.* 900-1370 m.) of west-central Nepal during winter. Scully (1879) and Ripley (1950b) did not come across it in Nepal.

The female specimen (March 24) had paired granular ovaries, as has already been reported by Biswas (1960b), the largest ovum measuring 1.5 mm.

Colours of soft parts : Iris bright lemon yellow, cere greenish grey with yellowish tinge on base, bill bluish slaty with black tip, legs and feet yellow, claws black, pads yellow.

Measurements :

	Wing	Tail	Bill	Culmen from the edge of cere
1 ♂ :	215	154	20	12.5
1 ♀ :	245	182	24	15.5

*18. **Accipiter nisus melaschistos** Hume. Indian Sparrow-Hawk.

This sparrow-hawk was not obtained by us, or by Scully (1879) or by Rand & Fleming (1957). Ripley (1950b, p. 365), however, collected a specimen in eastern Nepal in February, and Biswas (1960a) found it in spring and summer between *c.* 3960 and 4570 m. in Khumbu, eastern Nepal.

19. **Accipiter virgatus affinis** Hodgson. Northern Besra Sparrow-Hawk.

CHITLANG VALLEY : Chitlang : 1 ♀ (June 28). NEPAL VALLEY : Thankot : 1 ♀ (April 11).

The Northern Besra Sparrow-Hawk was seen by us on several occasions in the Markhu and Chitlang valleys, but only a few were noticed in the Nepal Valley, although Proud (1955, p. 71) recorded it to be moderately common there throughout the year. Neither Scully (1879), nor Ripley (1950b) found it in Nepal. Rand & Fleming (1957, p. 53), who collected a single specimen at Kaski (? western Nepal) in December, noted it to be uncommon.

Both my specimens had remains of birds in their stomachs.

Measurements : 2 ♀♀ : Wing 199, 206 ; tail 164, 167 ; bill 23, — ; culmen from the edge of cere 15.5, —.

*20. **Buteo rufinus rufinus** (Cretzschmar). Longlegged Buzzard.

Although Scully (1879, p. 225) recorded the Longlegged Buzzard as tolerably common in the plains, tarai, and Nepal Valley in winter, and Proud (1949, p. 717) as common in the Valley from September to April, it was not found in Nepal either by us or by Ripley (1950b) or by Rand & Fleming (1957).

*21. **Buteo hemilasius** Temminck & Schlegel. Upland Buzzard.

This buzzard was not found by us, nor by Scully (1879) or by Rand & Fleming (1957), but Ripley (1950b, p. 365) saw one at Thimi, Nepal Valley, in December.

*22. **Buteo buteo japonicus** (Temminck & Schlegel). Common Buzzard.

The Common Buzzard was not obtained by us or by Ripley (1950b) in Nepal. Scully (1879, p. 225) found it in the Nepal Valley in winter, and Rand & Fleming (1957, p. 54) recorded it from western and west-central Nepal (275 and 2440 m.) in winter.

23. **Butastur teesa** (Franklin). White-eyed Buzzard-Eagle.

DUN : Hitaura : 1 juv. unsexed (June 14).

The White-eyed Buzzard-Eagle was rarely seen by us in the tarai and dun, and never in the Nepal Valley. Scully (1879) did not record it from Nepal. Ripley (1950b, p. 365) obtained a single specimen in eastern Nepal at *c.* 1520 m., and Rand & Fleming (1957, p. 54) occasionally found it in eastern Nepal but rarely in western.

My specimen has the forehead, head, and nape rufous with dark brown to black shaft stripes, back and mantle rufous brown, under-side rufous brown with dark brown shaft stripes, but with no such stripe on the cheek or chin.

Its stomach contained the feet of a gallinaceous bird and meat.

*24. **Spizaëtus nipalensis nipalensis** (Hodgson). Hodgson's Hawk-Eagle.

The only record of Hodgson's Hawk-Eagle from Nepal since Hodgson's time appears to be that of Rand & Fleming (1957, p. 54) who occasionally saw it in the foothills.

25. **Spizaëtus limnaeetus limnaeetus** (Horsfield). Changeable Hawk-Eagle.

DUN : Hitaura : 1 ♀ (July 4).

This hawk-eagle was noticed by us on a very few occasions during spring and summer in the central dun. The above specimen appears to be the only example collected in Nepal since Hodgson's days. It had an exhausted ovary.

Measurements : 1 ♀: Wing 433, tail 275 +, bill 46, culmen from the edge of cere 34.

*26. **Hieraaëtus fasciatus fasciatus** (Vieillot). Bonelli's Eagle.

The last record of Bonelli's Eagle from Nepal was made by Scully (1879, p. 224) who did not find it to be very common in the Nepal Valley.

27. **Aquila chrysaëtos daphanea** Severtzov. Central Asian Golden Eagle.

Post-Hodgsonian records of the Golden Eagle in Nepal appear to be very few. Thus, Smythies (1950, p. 517) observed it once on Nagar Jong (Nepal Valley) in December, where Proud (1955, p. 70) often found it soaring in winter ; and Biswas (1960a) noted it on a few occasions in eastern Nepal between *c.* 1830 and 3050 m. in winter. Besides, there is a doubtful record from Manangbhot, central Nepal, by Lowndes (1955, p. 36). No specimen of this eagle seems to have been collected in Nepal during the past 100 years or more.

*28. **Aquila heliaca heliaca** Savigny. Imperial Eagle.

Since Hodgson left Nepal the only record of the occurrence of the Imperial Eagle in that country appears to be that of Proud (1955, p. 71) who often observed it in the Nepal Valley in January-February.

*29. **Aquila rapax vindhiana** Franklin. Tawny Eagle.

Hodgson's (Gray & Gray, 1846, p. 40) is the only record for this eagle in Nepal.

*30. **Aquila nipalensis nipalensis** (Hodgson). Steppe Eagle.

Neither Ripley (1950b), nor Rand & Fleming (1957) or we found the Steppe Eagle in Nepal. Scully (1879, p. 223) saw it only once in the Nepal Valley, and Proud (1955, p. 71) has recorded it as fairly common there in winter.

*31. **Aquila clanga** Pallas. Greater Spotted Eagle.

The only records of the Greater Spotted Eagle from Nepal are Hodgson's (Gray & Gray, 1846, p. 40) and Rand & Fleming's (1957, p. 54). The last-named authors found it several times in the lowlands of both western and eastern Nepal.

32. **Ictinaëtus malayensis perniger** (Hodgson). Indian Black Eagle.

MARKHU VALLEY : Deorali : 2 ♂♂ (May 1). NEPAL VALLEY : Thankot : 1 ♂, 1 ♀ (March 23, 26).

The Black Eagle was not infrequently seen by us between Bhimphedi and the Nepal Valley. Proud (1949, p. 717) found it throughout the year over the ranges bordering the Nepal Valley, and Ripley (1950b, p. 365) saw it only in western Nepal at *c.* 1520 m. Biswas (1960a) observed it on a few occasions in central Nepal in January and in eastern Nepal in June. Neither Scully (1879), nor Rand & Fleming (1957) reported it from Nepal.

The March specimens had breeding gonads. One of the Deorali specimens had the remains of a bat in the stomach.

Measurements :

	Wing	Tail	Bill	Culmen from the edge of cere
3 ♂♂:	563, 573, 580	315, 319, 326	40, 41, 43	28.5, 29, 30.5
1 ♀:	600	350	46	32

It may be noted here that the measurements of the wing and tail as given by Baker (1928, p. 83) for this form, are much too small.

According to Baker (op. cit., p. 82), the 5th primary from outside is the longest in the genus *Ictinaëtus*. This, however, is not true for my specimens in which the longest primary is the 6th one from outside.

*33. **Haliaeetus leucoryphus** (Pallas). Pallas's Fishing Eagle.

We did not come across Pallas's Fishing Eagle in Nepal. Scully (1879, p. 225) observed a few examples in the Nepal Valley generally except during the winter months ; Ripley (1950b, p. 365) found it in the western lowlands in winter ; and Rand & Fleming (1957, p. 54) encountered it in the lowlands of both western and eastern Nepal.

*34. **Icthyophaga ichthyaetus** (Horsfield). Greyheaded Fishing Eagle.

This fishing eagle has not been reported from Nepal since Hodgson's days.

35. **Icthyophaga nana plumbea** (Jerdon). Himalayan Greyheaded Fishing Eagle.

DUN : Hitaura : 3 ♂♂, 1 ♀, 1 unsexed (May 17—June 3).

The Greyheaded Fishing Eagle was frequently seen by us in the dun, particularly along the larger rivers, such as the Rapti and Samri. Biswas (1960a) found it at *c.* 850 m. in central Nepal in January, and in eastern

Nepal at *c.* 3655 and 4420 m. in May. It was not reported from Nepal by either Scully (1879), or Ripley (1950b), or Rand & Fleming (1957).

My female specimen (June 3) is very worn, with its tail moulting.

Colours of soft parts: Iris golden yellow, bill black, plumbeous on base and lower mandible, cere slaty, legs and feet dull white with bluish tinge at 'knees' and on the digits, claws black, pads dirty white.

Measurements:

	Wing	Tail	Bill	Culmen from the edge of cere
3 ♂♂:	426, 428, 441	215, 216, 228	43, 45 (2)	34 (2), 35
1 ♀:	—	—	45	34.5
1 unsexed:	467	238	48	36.5

The unsexed bird appears to be a female from size.

36. **Torgos calvus** (Scopoli). Black Vulture.

BHABAR: Amlekhganj: 1 ♂, 1 ♀ (August 4).

The Black Vulture is not uncommon in the Nepal Valley, being usually found near burning ghats on rivers. It does not, however, appear common in the tarai, bhabar and dun as about Kathmandu.

It has been reported as a permanent resident in the Nepal Valley (Scully, 1879, p. 217; Proud, 1949, p. 716), and as winter visitor to the plains, tarai, duns, and the Markhu Valley (Scully, loc. cit.). Ripley (1950b) did not find it in Nepal. Rand & Fleming (1957, p. 55) noted it in the lowlands and foothills in winter. Biswas (1960a) reported it from eastern Nepal at *c.* 1980 m. in early February and at *c.* 1520 m. in June.

Measurements:

	Wing	Tail	Bill	Culmen from the edge of cere
1 ♂:	566	248	66+	47+
1 ♀:	592	250	–	–

*37. **Aegypius monachus** (Linnaeus). Cinereous Vulture.

The Cinereous Vulture was not found by us in Nepal, nor did Ripley (1950b) record it thence. Scully (1879, p. 217) noted it as scarce in the Nepal Valley, and Rand & Fleming (1957, p. 55) found it in the eastern Nepal foothills as an uncommon bird in winter.

*38. **Gyps fulvus fulvescens** Hume. Griffon Vulture.

Gyps fulvescens Hume, 1869, My Scrap Book **1**: 15, 19. [Punjab, northern Rajasthan and 'North-West Provinces' (= Uttar Pradesh), north and west of Etawah = Gurgaon, Punjab, according to Baker, 1928, p. 11.]

The only records of the Griffon Vulture from Nepal are Hodgson's (Gray & Gray, 1846, pp. 37-38) in the hills, and Scully's (1879, p. 218) in the Nepal Valley in winter.

39. **Gyps himalayensis** Hume. Himalayan Griffon.

Gyps himalayensis Hume, 1869, My Scrap Book **1**: 12, 15. (Himalayas from Kabul to Bhutan=Simla, according to Baker, 1922c, p. 583.)

The Himalayan Griffon was seen by us only once, and that was in Kathmandu, Nepal Valley, in mid-March. Scully (1879, p. 218) found it in small numbers in the Valley during winter ; Lowndes (1955, p. 36) observed a pair in Manangbhot, central Nepal, in June-July ; Rand & Fleming (1957, p. 55) found it in the eastern Nepal foothills during winter ; Biswas (1960a) reported it from Khumbu, eastern Nepal, at *c.* 3660 m. in February. Ripley (1950b) does not mention it in his list.

40. **Gyps indicus tenuirostris** G. R. Gray. Himalayan Longbilled Vulture.

This vulture was seen by us on a few occasions only in the Nepal Valley, mainly near villages. Scully (1879, p. 219) reported it to be tolerably common in the Valley where Smythies (1950, p. 517) and Ripley (1950b, p. 366) also observed it. Rand & Fleming (1957, p. 55) found it to be common in the western tarai in winter.

41. **Gyps bengalensis** (Gmelin). Whitebacked Vulture.

DUN : Hitaura : 1 ♀ (June 3).

This is the commonest vulture of the Nepal Valley and the dun. Proud (1949, p. 716) observed that it became scarcer in the Valley during the coldest months. Stevens (1925c, p. 874) recorded it from the Mai Valley, eastern Nepal, at over 2440 m. in March.

My specimen had non-breeding gonad.

Measurements : 1 ♀ : Wing 555, tail 238, tarsus 94, bill 62 [*cf.* Baker's (1928, p. 19) ' tarsus 108 to 124 mm. ; culmen 71 to 81 mm.' evidently errors].

42. **Neophron percnopterus ginginianus** (Latham). Smaller Scavenger Vulture.

BHABAR : Amlekhganj : 1 unsexed (June 8).

The Scavenger Vulture was seen by us in the plains, tarai, and bhabar. Scully (1879) and Ripley (1950b) did not report it from Nepal.

My specimen has a light greyish wash all over.

Measurements : I unsexed : Wing 434, tail 210, bill 57 [*cf.* measurements given by Baker (1928, p. 23) wing 443-482, tail 228-251, culmen 72-85].

*43. **Gypaëtus barbatus hemachalanus** Hutton. Himalayan Lämmergeier.

The Lämmergeier or Bearded Vulture was not found by us or by Rand & Fleming (1957). Nevertheless, it was observed in the Nepal Valley once by Scully (1879, p. 221) in winter and occasionally by Proud (1949, p. 716) ; in the northern central Nepal in the Gandak-Kosi watershed once in autumn by Smythies (1948, p. 442) and once in spring by Proud (1952a, p. 366), and several pairs in Manangbhot during May-

September by Lowndes (1955, p. 36) ; once in winter in eastern Nepal about Dhankuta by Ripley (1950b, p. 366), and several times in Solu-Khumbu between February and May by Biswas (1960a).

*44. **Circus cyaneus cyaneus** (Linnaeus). Hen-Harrier.

We did not come across the Hen-Harrier in Nepal, nor did Ripley (1950b) or Rand & Fleming (1957). Scully (1879, p. 226) recorded it to be fairly common in the Nepal Valley during winter, but Proud (1949, p. 717) found only a few specimens there during March-April, none in autumn or winter.

*45. **Circus macrourus** (S. G. Gmelin). Pale Harrier.

Neither Rand & Fleming (1957) nor we found the Pale Harrier in Nepal, but Scully (1879, p. 226) recorded it in winter in the Nepal Valley where Proud (1949, p. 717) also found it occasionally on passage in spring, and Ripley (1950b, p. 366) reported it from eastern Nepal in winter.

*46. **Circus pygargus** (Linnaeus). Montagu's Harrier.

We were unable to find this harrier in Nepal, and so were Scully (1879) and Ripley (1950b), but Proud (1949, p. 717) recorded it in the Nepal Valley on passage in April and November, and Rand & Fleming (1957, pp. 55-56) noted it as an uncommon bird in the eastern Nepal tarai in winter.

*47. **Circus melanoleucos** (Pennant). Pied Harrier.

The Pied Harrier was not come across by us, but it has been reported in winter from the plains and tarai of central Nepal by Scully (1879, p. 226) and Ripley (1950b, p. 366), and from the tarai of eastern Nepal by Rand & Fleming (1957, p. 56).

*48. **Circus aeruginosus aeruginosus** (Linnaeus). Marsh Harrier.

The Marsh Harrier was not found by Ripley (1950b) or by us. Scully (1879, p. 226) reported it to be common during winter in the Nepal Valley, central tarai, and plains ; Proud (1949, p. 717) noted it to be the commonest harrier of the Nepal Valley in autumn and winter ; and Rand & Fleming (1957, p. 56) observed it in the western and eastern lowlands in winter.

*49. **Circaëtus gallicus** (Gmelin). Short-toed Eagle.

Hodgson's collection (Gray & Gray, 1846, p. 41) furnishes the sole record of this eagle from Nepal.

50. **Spilornis cheela cheela** (Latham). Crested Serpent Eagle.

DUN : Hitaura : 1 ♂, 1 ♀, 1 subad. ♀ (May 18, June 1, 18). NEPAL VALLEY : Thankot : 1 ♀ (April 2).

In the Nepal Valley the Serpent Eagle was seen on several occasions near the crests of the hills surrounding it—above Thankot, Godavari, and Burhanilkantha. In the central dun, however, it was more common. Scully (1879, p. 224) found it tolerably common in the Valley throughout the year, but Proud (1949, p. 717) observed that it appears to leave that area in winter.

The subadult female specimen (June 1) is very worn and just beginning to moult. Its oviduct showed immature condition. The adult female from Thankot (April 2) was laying.

The stomachs of the Hitaura specimens contained frogs.

Measurements :

	Wing	Tail	Bill	Culmen from the edge of cere
1 ♂ :	477+	300	46	32
2 ♀♀ :	480+, 516	292+, 330	47, 47.5	35, 36

Family FALCONIDAE

51. **Microhierax caerulescens caerulescens** (Linnaeus). Himalayan Falconet.

BHABAR : Amlekhganj : 1 ♂ (March 9). DUN : Hitaura, Kusumtar : 3 ♂♂, 3 juv. ♂♂, 1 ♀, 3 juv. ♀♀ (May 19, June 2-19, July 12-28).

The Himalayan Falconet was found by us in the forests of the central bhabar and dun only, and it did not appear to be particularly common there. Rand & Fleming (1957, p. 57) also noted it to be an uncommon bird, and Scully (1879) did not report it at all.

One of my adult male specimens (Hitaura, May 19) has the crown in moulting condition. A female specimen on June 4 had an exhausted ovary and a shrivelled oviduct.

The juvenile specimens taken July 12-13 have the forehead and supercilium chestnut, chin to abdomen white, and dirty yellow bill with black on the anterior half of culmen. The juvenile specimens taken later have, however, more black on bill. The stomachs of the juvenile specimens had grasshoppers and dragonflies.

Measurements :

	Wing	Tail	Culmen from the edge of cere
4 ♂♂ :	102 (3), 104	60, 62, 64, 65	10, 10.5 (2) 11
1 ♀ :	109	65	11

*52. **Falco cherrug milvipes** Jerdon. Cherrug Falcon.

The Cherrug Falcon has so far been taken in Nepal only by Hodgson (Gray & Gray, 1846, p. 43).

*53. **Falco jugger** J. E. Gray. Laggar Falcon.

The Laggar Falcon was not met with by us or by Ripley (1950b). Scully (1879, p. 222), however, recorded it once in the Nepal Valley in winter, and Rand & Fleming (1957, p. 57) also found it once (two specimens) in the eastern lowlands in winter.

*54. **Falco peregrinus calidus** Latham. Peregrine Falcon.

The post-Hodgsonian records of the Peregrine Falcon in Nepal are those of Scully's (1879, p. 221) and Proud's (1949, p. 716) both of whom found it as a winter visitor in the Nepal Valley.

*55. **Falco peregrinus peregrinator** Sundevall. Shahin.

The only record of the Shahin from Nepal is Hodgson's (Gray & Gray, 1846, p. 44).

*56. **Falco subbuteo subbuteo** Linnaeus. Hobby.

Hodgson's collection (Gray & Gray, 1846, p. 44) provides the sole record for the Hobby in Nepal.

*57. **Falco severus severus** Horsfield. Oriental Hobby.

Since Hodgson's time the only specimen of the Oriental Hobby from Nepal was taken by Rand & Fleming (1957, p. 57) who found it several times in the western lowlands during winter. Proud (1949, p. 716) describes it as a summer visitor in the Nepal Valley.

58. **Falco chicquera chicquera** Daudin. Redheaded Merlin.

TARAI: Simra : 1 ♂, 1 ♀ (March 4).

The Redheaded Merlin is not an uncommon bird in the Nepal Valley or in the central tarai, but not many are seen in the dun of central Nepal. It seems to prefer places not very far from villages. Ripley (1950b) has not recorded it from Nepal.

It was breeding early in March.

Measurements :

	Wing	Tail	Bill	Culmen from the edge of cere
1 ♂:	206	134	22.5	14.5
1 ♀:	230	148	25	16

*59. **Falco vespertinus amurensis** Radde. Redlegged Falcon.

The only record of this falcon from Nepal is the single skin taken by Hodgson (Gray & Gray, 1846, p. 45), obviously on passage.

*60. **Falco tinnunculus tinnunculus** Linnaeus. European Kestrel.

The European Kestrel was not found by us or by Ripley (1950b). Scully (1879, p. 223) reported it as a winter visitor in central Nepal from the Nepal Valley down to the plains except the bhabar. Proud (1949, p. 717) observed it as a winter visitor in the Valley. Rand & Fleming (1957, p. 57) obtained it in winter between *c.* 275 and 2285 m. both in western and in eastern Nepal. They, however, noted it to be commoner in the east.

61. **Falco tinnunculus interstinctus** McClelland. Himalayan Kestrel.

CHITLANG VALLEY : Chitlang : 2 ♂♂ (April 26, 27).

The Himalayan Kestrel is not uncommon in the tarai and dun up to the Nepal Valley in spring. Biswas (1960a) reported it from eastern Nepal at *c.* 1525 m. in June.

Measurements : 2 ♂♂ : Wing 235, 252 ; tail 153, 169 ; bill 20, 21 ; culmen from the edge of cere 14, 15.

Family PANDIONIDAE

*62. **Pandion haliaetus haliaetus** (Linnaeus). Osprey.

We were unable to find the Osprey in Nepal, so were Scully (1879) and Ripley (1950b). However, Proud (1949, p. 716) observed it on and off throughout the year in the Nepal Valley, and Rand & Fleming (1957, p. 56) came across it occasionally in the lowlands in winter.

Order CICONIIFORMES

Family ARDEIDAE

*63. **Ardea insignis** Hume. Great Whitebellied Heron.

Ardea insignis 'Hodgson' Hume, 1870, Str. Feath. **6**: 470. (Sikkim tarai, Bhutan duars) ex *Ardea insignis* Hodgson, 1844, *nom. nud.* Hume's name is available, since its citation as a synonym of *Ardea nobilis* Blyth and *Ardea sumatrana* Raffles are based on misidentification.

The only record of the Great Whitebellied Heron from Nepal is based on Hodgson's collection (Gray & Gray, 1846, p. 133).

*64. **Ardea cinerea rectirostris** Gould. Eastern Grey Heron.

Ardea rectirostris Gould, 1843, Proc. zool. Soc. Lond. (11) : 22. (New South Wales ' =India ? ', according to Stone & Mathews, 1913, p. 142 ; restricted to India by Ripley, in press).

The Grey Heron was not obtained by us or by Scully (1879). Ripley (1950b, p. 363) found it in the tarai during winter, and Rand & Fleming (1957, pp. 48-49) who identified their specimens as *A. c. cinerea* Linnaeus, came across it on a few occasions in the lowlands of western and eastern Nepal between *c.* 275 and 915 m. in winter.

*65. **Ardea purpurea manilensis** Meyen. Eastern Purple Heron.

The Purple Heron was not met with by us or by Scully (1879). Smythies (1950, p. 518) reported it from the Nepal Valley. Ripley (1950b, p. 363) saw it in the tarai in winter, and Rand & Fleming (1957, p. 48) found it on a few occasions only in the lowlands in winter. I am unable to trace any breeding record from Nepal to support Ripley (in press).

66. **Butorides striatus chloriceps** (Bonaparte). Indian Little Green Heron.

Ardea chloriceps 'Hodgs.' Bonaparte, 1857, Consp. Gen. Av. **2** : 129. (Nepal, restricted to Hitaura, Chisapani Garhi district, by Biswas, 1959a, p. 288.)

BHABAR : Amlekhganj : 1 ♂, 1 juv. ♀ (March 10). DUN : Hitaura, Kusumtar : 3 ♂♂, 2 subad. ♂♂, 1 ♀ (May 17-31, June 14).

The Little Green Heron is found during spring and summer in small numbers in the central bhabar and dun, usually perched on riverside trees with dense foliage. It is generally found singly, but on several occasions we observed it in pairs. Scully (1879) did not include it in his list of Nepal birds. Ripley (1950b, p. 363) found it in eastern Nepal, and Rand & Fleming (1957, p. 49) in western and west-central Nepal.

Remains of fishes and frogs were found in the stomachs of some of my specimens.

It was breeding in May. A male taken on May 31 had much enlarged testes, and a female had fully formed eggs on May 20.

The subadult males (May 26, June 14) still have some dark brown streaks on chin.

Colours of soft parts : Iris yellow ; orbital skin green ; upper mandible black ; lower mandible green on base, black along the edges, sides of basal and anterior third, and pale dull yellowish green elsewhere ; legs and feet dull brownish yellow with chrome yellow on the hinder aspects of legs; claws horny ; pads chrome yellow.

Measurements :

	Wing	Tail	Bill from posterior edge of nostril
4 ♂♂ :	171, 181 (2), 183	60.5, 63, 65, 66	57.5, 60, 62 (2)
1 ♀ :	182	64	61

Regarding the use of Bonaparte's name for this bird, see Biswas (loc. cit.).

67. **Ardeola grayi** (Sykes). Pond Heron.

DUN : Hitaura : 2 ♂♂ (May 19, June 5). NEPAL VALLEY : Thankot, Karmanasa river (south of Patan) : 2 ♂♂ (April 13, May 9).

The Pond Heron is common at suitable places from the plains of central Nepal up to the Nepal Valley. Rand & Fleming (1957, p. 49) reported it from western and west-central Nepal.

It was breeding in May. A male taken May 9 had fully developed testes.

My breeding male specimens each has four long greyish white lanceolate feathers on the anterior dorsal side of the neck, which have not been mentioned by Baker (1929, p. 354). Moreover, all my breeding male specimens have the occipital crests buff and not white as stated by Baker (loc. cit.).

Colours of soft parts: Iris lemon yellow ; orbital skin greenish yellow ; bill greenish yellow with blue on base, horny on the middle part of culmen, and black on the top and sides of the anterior third ; legs and feet dull green ; claws pale horny ; pads dingy yellowish white.

Measurements : 4♂♂ : Wing 218, 221, 226, 233 ; tail 75, 83, 85, 87 ; bill from the posterior edge of nostril 56, 60, 62 (2).

68. **Bubulcus ibis coromandus** (Boddaert). Cattle Egret.

NEPAL VALLEY : Kathmandu, Harisidhi, Godavari : 5 ♂♂, 1 subad. ♂, 3 ♀♀ (May 9-12, July 1).

The Cattle Egret is a common bird of central Nepal from the plains up to the Nepal Valley. A large breeding colony was observed by us in the Valley at Harisidhi on a *Ficus* tree in May. Rand & Fleming (1957, p. 49) reported it from the eastern Nepal tarai.

My subadult specimen (Godavari, May 12) is completing a general moult to attain the adult breeding dress, but without any trace of orange-buff plumes from the interscapular region. Its gonads, moreover, were small in size, the right one measuring 7×5 mm., and the left 10×5.5 mm. (cf. measurements of breeding testes given below). All the adult birds are in full breeding plumage, except two Kathmandu specimens (♂♀, July 1) which have only traces of orange-buff here and there on the plumage.

Some of the July specimens are worn, but a male bird is particularly so. Its wing and tail are very much worn, with the central rectrices in moult.

The May 9 specimens from Harisidhi all had breeding gonads. The male had the right testis measuring 22×12 mm., and the left 27×13 mm., one of the females had a 30×19 mm., ovary with the largest ova 11.5 and 12 mm., the other female had a 17×14 mm. ovary, the largest ovum of which was 7 mm.

Measurements :

	Wing	Tail	Bil from the posterior edge of nostril
5 ♂♂ :	252, 252+, 255 262,—	90, 92, 93, 100,—	47.5, 52, 53 (2), 54
3 ♀♀ :	241, 242, 255	88, 91, 95	50, 51,—

Since the habits and behaviour of the Cattle Egret are very different from those of the Pond Heron, I am unable to agree with Bock (1956, pp. 18, 36) in placing both of them in the genus *Ardeola* (see also Ripley, in press).

*69. **Egretta alba modesta** (J. E. Gray). Eastern Large Egret.

The Large Egret was not found by us. Scully (1879, p. 360) recorded it as a winter visitor to the Nepal Valley and Nawakot district (central Nepal) but not in the plains, while Ripley (1950b, p. 363) found it in winter only in the tarai and not higher, and Rand & Fleming (1957, p. 49) noted it in the lowlands in winter.

*70. **Egretta garzetta garzetta** (Linnaeus). Little Egret.

We did not come across this egret in Nepal. Scully (1879, pp. 360-361) found it to be a bird of the tarai, plains, and parts of the Nawakot district, central Nepal, and saw only a few stray ones in the Nepal Valley in autumn. Proud (1949, p. 719), on the other hand, records it as a resident species of the Valley. Ripley (1950b, p. 363) took a single specimen in the Valley at Thankot in spring, and Rand & Fleming (1957, pp. 49-50) found it between *c.* 275 and 915 m. in west-central Nepal in winter.

*71. **Egretta intermedia palleuca** Deignan. Smaller Egret.

We were unable to find this egret in Nepal, and so were Hodgson, and Rand & Fleming (1957). It was Scully (1879, p. 360) who first reported the species from Nepal. He found it in the Nepal Valley between September and December only, in the Nawakot district in November, and in the plains and tarai in December. Ripley (1950b, p. 363) observed it in winter in the tarai but not higher.

Regarding the use of Deignan's name for this bird, see Ripley in press.

72. **Nycticorax nycticorax nycticorax** (Linnaeus). Night Heron.

Although Scully (1879, p. 361) and Proud (1949, p. 719) both record the Night Heron as a very common resident bird of the Nepal Valley, we observed it in spring and summer only on a few occasions on trees in the neighbourhood of water. Ripley (1950b) and Rand & Fleming (1957) do not report it from Nepal.

[**Ixobrychus minutus minutus** (Linnaeus). Little Bittern.

Nepal has been included within the range of this species in almost all the standard works on Indian avifauna. Although it might possibly occur there, I am unable to trace any authentic record to support it.]

*73. **Ixobrychus sinensis** (Gmelin). Yellow Bittern.

The occurrence of the Yellow Bittern in Nepal is known only from Hodgson's collection (Gray & Gray, 1846, pp. 134-135).

74. **Ixobrychus cinnamomeus** (Gmelin). Cinnamon Bittern.

DUN : Hitaura : 3 ♂, 1 ♀ (June 19, July 28, August 1).

This appears to constitute the first record of the occurrence of the Cinnamon Bittern in Nepal. It was found by us in summer only in the dun of central Nepal. It occurs in small numbers in deep cover of reed beds, especially in shady parts of dense forests.

Measurements :

	Wing	Tail	Bill from the posterior edge of nostril
3 ♂♂ :	151, 152, 154	44, 46, 48	45, 46, 47
1 ♀ :	145	45	45

*75. **Botaurus stellaris stellaris** (Linnaeus). Bittern.

The Bittern is known from Nepal only through Hodgson's collection (Gray & Gray, 1846, p. 135).

Family THRESKIORNITHIDAE

*76. **Threskiornis melanocephala** (Latham). White Ibis.

The White Ibis was not found by us or by Scully (1879) or by Ripley (1950b), but Rand & Fleming (1957, pp. 50-51) observed it occasionally in the lowlands of eastern Nepal. Hodgson's collection (Gray & Gray, 1846, p. 137) from the tarai is the only other record of this bird from Nepal.

77. **Pseudibis papillosa papillosa** (Temminck). Indian Black Ibis.

TARAI : Simra : 1 ♂ (March 5). DUN : Hitaura : 1 ♂ (June 2).

The Black Ibis was met with by us sparsely near cultivated areas in the central tarai and dun. Scully (1879) did not find it in Nepal, and Ripley (1950b, p. 363) observed it but once at *c.* 150 m. in western Nepal ; nevertheless, Rand & Fleming (1957, p. 51) seem to have found it fairly common in open fields of the western tarai.

Measurements : 2 ♂♂ : Wing 370, 392 ; tail 174, 185 ; bill from the anterior edge of nostril 126, 132.5.

*78. **Plegadis falcinellus falcinellus** (Linnaeus). Glossy Ibis.

*79. **Platalea leucorodia major** Temminck & Schlegel. Spoonbill.

Hodgson's collection (Gray & Gray, 1846, pp. 135-136) of the Glossy Ibis and Spoonbill, the latter from the tarai, represent the only records of these species from Nepal.

Family CICONIIDAE

*80. **Ibis leucocephalus** (Pennant). Painted Stork.

Hodgson's (Gray & Gray, 1846, p. 136) is the only record of the Painted Stork from Nepal.

*81. **Anastomus oscitans** (Boddaert). Openbill.

The occurrence of the Openbill in Nepal is based solely on Ripley's (1950b, p. 364) record from the tarai.

82. **Ciconia episcopus episcopus** (Boddaert). Whitenecked Stork.

DUN : Hitaura : 1 ♂ (May 21).

The Whitenecked Stork was found by us only on a few occasions around Hitaura in the central dun on the bank of the Rapti River in summer. Scully (1879, p. 360) reported it common in the Nepal Valley from May to December and in the Nawakot district in November. Proud (1949, p. 719) occasionally found it in the Valley throughout the year.

Ripley (1950b, p. 364) saw it in the tarai in winter as an uncommon bird, but Rand & Fleming (1957, p. 50) record it as the commonest stork from the plains up to *c.* 610 m. in western Nepal in winter.

Measurements : 1 ♂ : Wing 507, tail 182, bill from the posterior edge of nostril 139.

*83. **Ciconia nigra** (Linnaeus). Black Stork.

The Black Stork was not met with by us or by Ripley (1950b), but Scully (1879, p. 359) recorded it to be common in the Nepal Valley and Nawakot district from September to December, and Rand & Fleming (1957, p. 50) occasionally found it in the eastern lowlands up to *c.* 915 m. in winter.

*84. **Xenorhynchus asiaticus asiaticus** (Latham). Blacknecked Stork.

The only record of the Blacknecked Stork from Nepal since Hodgson's time is Ripley's (1950b, p. 364). He found it in the tarai as an uncommon bird.

*85. **Leptoptilos dubius** (Gmelin). Adjutant.

The post-Hodgsonian records of the Adjutant from Nepal have been made by Ripley (1950b, p. 364) who found it in the tarai but not as a common bird, and by Biswas (1960a) who observed a pair in eastern Nepal at *c.* 1525 m. in June. There is also a doubtful sight record by Rand & Fleming (1957, p. 50) from the western lowlands.

*86. **Leptoptilos javanicus** (Horsfield). Lesser Adjutant.

The only authentic record of this adjutant from Nepal is due to Rand & Fleming (1957, p. 50) who found it in the eastern lowlands in winter.

Order ANSERIFORMES

Family ANATIDAE

*87. **Anser anser rubrirostris** Swinhoe. Greylag Goose.

The only record of the occurrence of the Greylag Goose in Nepal is based on Hodgson's collection (Gray & Gray, 1846, p. 144).

*88. **Anser indicus** (Latham). Barheaded Goose.

The post-Hodgsonian records of the Barheaded Goose from Nepal are due to Ripley (1950b, p. 364) who saw it on the Karnali River, western Nepal, in December, and Biswas (1960a) who observed a flock on passage northward along the Dudh Kosi River, Khumbu, eastern Nepal, at over 3650 m. on April 5.

*89. **Cygnus cygnus cygnus** (Linnaeus). Whooper Swan.

Hodgson's collection (Gray & Gray, 1846, p. 144) represents the only record of the Whooper Swan in Nepal.

*90. **Dendrocygna javanica** (Horsfield). Lesser Whistling Teal.

Scully (1879) did not find this whistling teal in Nepal, but Rand & Fleming (1957, p. 51) recorded it, though not as a common bird, in the eastern lowlands. There is also a doubtful sight record from the eastern lowlands by Ripley (1950b, p. 364).

*91. **Tadorna ferruginea** (Pallas). Ruddy Sheld-duck, or Brahminy Duck.

Scully (1879, p. 362) found the Brahminy Duck in the Nepal Valley from late September to mid-December and from mid-March to April, in the Nawakot district in November, and in the central plains and tarai in December. Ripley (1950b, p. 364) reported it in the western tarai in December, and in the Valley in April. Rand & Fleming (1957, p. 51) recorded it as very common in the lowlands during winter. Biswas (1960a) found it preparing to breed in small numbers on high altitude lakes (*c.* 5030-5330 m.) of Khumbu, eastern Nepal, in May.

*92. **Tadorna tadorna** (Linnaeus). Common Sheld-duck.

Hodgson's collection of the Common Sheld-duck furnishes the only record of the species from Nepal.

*93. **Anas acuta** Linnaeus. Pintail.

Scully (1879, p. 363) found it to be the commonest duck of the Nepal Valley during winter, especially during September-November and March-April. Ripley (1950b, p. 364) observed it in the Valley in winter. Rand & Fleming (1957) do not report it from Nepal.

94. **Anas crecca crecca** Linnaeus. Common Teal.

The Common Teal was found by us in a tank in Kathmandu in mid-March and early April, but no specimen was collected. It was recorded as common in winter in the Nepal Valley by Scully (1879, p. 363), but Proud (1949, p. 719) noted it on passage during August-October, and as remaining in the Valley only for a short time. Ripley (1950b, p. 364) reported it from both the Valley and eastern tarai (Kosi River) during November-April. Rand & Fleming (1957, p. 52) found it the commonest teal in winter.

*95. **Anas poecilorhyncha poecilorhyncha** Forster. Spotbill Duck.

This duck is known from Nepal only through Hodgson's collection (Gray & Gray, 1846, p. 146).

*96. **Anas platyrhynchos** Linnaeus. Mallard.

After Hodgson, only Rand & Fleming (1957, p. 51) have recorded the Mallard from Nepal. They found it only once (four specimens) on the Kali Gandak River at *c.* 2740 m., west-central Nepal, in November, *97. **Anas strepera strepera** Linnaeus. Gadwall.

Scully (1879, p. 362) found that the Gadwall did not remain in the Nepal Valley throughout the winter, but that it was pretty common in September-November and again in March-April. Ripley (1950b, p. 364) observed it both in the Valley and in eastern Nepal (Kosi River) from November to April. Rand & Fleming (1957) did not find it in Nepal.

*98. **Anas penelope** Linnaeus. Wigeon.

Both Scully (1879, p. 363) and Ripley (1950b, p. 364) observed the Wigeon in the Nepal Valley during winter. Proud (1949, p. 719) saw a single specimen (a male) there shot by local people in May. Lowndes (1955, p. 37) came across a single male example in full breeding dress in Manangbhot, central Nepal, in June. Biswas (1960a) found it in high altitude lakes (*c.* 5030-5330 m.) of Khumbu, eastern Nepal, in May. Rand & Fleming (1957) did not include this species in their list.

99. **Anas querquedula** Linnaeus. Garganey.

We observed the Garganey in a tank in Kathmandu, Nepal Valley, in mid-March and early April. It was recorded from the Valley in winter by Scully (1879, p. 363), Ripley (1950b, p. 364), and Proud (1955, p. 72); the last-named author observed, however, that most were on passage in September-October. Rand & Fleming (1957, p. 51) found it in the eastern lowlands in winter.

*100. **Anas clypeata** Linnaeus. Shoveller.

Although Scully (1879, p. 362) noted the Shoveller as a winter visitor to the Nepal Valley, being commonest on passage in October-November, the species has not since been recorded from Nepal.

*101. **Rhodonessa caryophyllacea** (Latham). Pinkheaded Duck.

The Pinkheaded Duck has not been reported from Nepal after Hodgson. Incidentally, this species is said to be recently extinct or nearly so, the last authentic record from the wild state having been made some 25 years ago. For a short history of this bird, see Ripley (1952a, pp. 903-904).

*102. **Netta rufina** (Pallas). Redcrested Pochard.

Ripley's (1950b, p. 364) is the only post-Hodgsonian record of the Redcrested Pochard from Nepal. He found it around the Nepal Valley during November-April.

*103. **Aythya ferina** (Linnaeus). Common Pochard.

The first record of the occurrence of the Common Pochard in Nepal is to be credited to Proud (1949, p. 719) who found a single male specimen in the Nepal Valley in January. Later, Ripley (1950b, p. 364) noticed it around the Valley between November and April ; and Lowndes (1955, p. 37) observed a small party with the males in breeding plumage, on June 10, in Manangbhot, central Nepal. Rand & Fleming (1957), did not find it in Nepal.

It may be noted, however, that no specimen of this species has yet been taken in Nepal.

*104. **Aythya nyroca** (Güldenstädt). White-eyed Pochard.

Scully's (1879, p. 363) is the last record of this pochard from Nepal. He found it in the Nepal Valley on passage and as a very common bird around Bichiakoh, central bhabar, in December.

*105. **Aythya fuligula** (Linnaeus). Tufted Duck.

Scully (1879) did not find the Tufted Duck in Nepal, but Ripley (1950b, p. 364) observed it in the Nepal Valley during November-April ; Rand & Fleming (1957, p. 52) found it fairly common in the lowlands in winter ; and Biswas (1960a) recorded it in May on high altitude lakes (*c.* 5030-5330 m.) in Khumbu, eastern Nepal.

*106. **Aythya marila marila** (Linnaeus). Scaup.

I am unable to trace any post-Hodgsonian record of the Scaup in Nepal.

*107. **Nettapus coromandelianus coromandelianus** (Gmelin). Cotton Teal.

After Hodgson's collection, Rand & Fleming's (1957, p. 52) is the only record of the Cotton Teal in Nepal. They found it fairly common in the tarai in winter.

*108. **Mergus merganser orientalis** Gould. Eastern Goosander.

Scully (1879, p. 364) observed it only on the Tadi river, Nawakot district, central Nepal, in winter, and Ripley (1950b, p. 364) found it common along the Karnali River, western Nepal, and in the dun, both in winter.

Order GALLIFORMES

Family PHASIANIDAE

*109. **Lerwa lerwa lerwa** (Hodgson). Snow Partridge.

The Snow Partridge was not found either by us or by Scully (1879) or Ripley (1950b), but Rand & Fleming (1957, p. 58) obtained specimens in the Kali Gandak Valley (*c.* 4570-4875 m.), west-central Nepal, in December. Smythies (1948, p. 442) observed it in the Gandak-Kosi watershed (*c.* 3660 and 4875 m.), central Nepal, in autumn ; and Biswas

(1960a) reported it from Khumbu (*c.* 4420-5790 m.), eastern Nepal, in February, March, and May.

*110. **Tetraogallus tibetanus aquilonifer** R. & A. Meinertzhagen. Sikkim Snow Cock.

The first record of the Sikkim Snow Cock from Nepal was made by Rand & Fleming (1957, p. 58) who obtained it in the Kali Gandak Valley (*c.* 4875 m.) west-central Nepal, in winter. Biswas (1960a) found it not uncommon between *c.* 4270 and 5330 m. in Khumbu, eastern Nepal, from February to May.

*111. **Tetraogallus himalayensis himalayensis** G. R. Gray. Himalayan Snow Cock.

Hodgson's single specimen of this snow cock from the ' Snowy Regions of Nepal ' (Gray & Gray, 1846, p. 126) was listed as coming from Kumaon by Ogilvie-Grant (1893, p. 107) without any apparent reason. However, it was left to Rand & Fleming (1957, p. 59) to provide the first indisputable record of its occurrence in Nepal. They found it between *c.* 4875 and 5180 m. in the Kali Gandak Valley, west-central Nepal, in winter.

*112. **Alectoris graeca chukar** (J. E. Gray). Chukor.

Perdix Chukar J. E. Gray, 1830, Illustr. Indian Zool. **1** (2) : 54. (India=Nepal, according to Baker, 1922e, p. 849, but=Srinagar, Dehra Dun district, Uttar Pradesh, according to Hellmayr, 1929, p. 136. The latter seems more reasonable.)

We did not come across the Chukor in Nepal, nor did Ripley (1950b). Scully (1879, pp. 348-349) noted it as common on certain parts of the hills bordering the Nepal Valley (*c.* 1525-1825 m.) during March-October. Lowndes (1955, p. 37) observed that it was plentiful in fields of Manangbhot, central Nepal, between *c.* 3050 and 3960 m. in summer. Rand & Fleming (1957, p. 59) found it in west-central Nepal from *c.* 2745 to 2895 m. in winter.

113. **Francolinus francolinus asiae** Bonaparte. Indian Black Partridge.

DUN : Hitaura : 9 ♂♂, 1 ♀ (May 15—June 23). NEPAL VALLEY : Thankot : 2 ♂♂ (April 14).

The Black Partridge is not found to be a common bird of the Nepal Valley, but is fairly abundant in the central dun in grassy patches near rivers and in cultivated fields. In May-June its call could be heard in all directions.

The Thankot specimens had much enlarged testes (26-28 mm. long), and one of the Hitaura males (June 4) had the right testis measuring 20 × 13 mm., and the left, 26 × 13 mm.

Remains of maggots were found in the stomach of a Thankot bird, *Colours of soft parts :* Iris dark brown, bill black, legs and feet orange-brown, claws horny, pads dingy white.

Measurements :

	11 ♂♂	1 ♀
Wing :	150, 152, 153, 155 (3), 157, 158, 159 (3)	147
Tail :	78, 82, 83+, 85 (3), 85+, 86(2), 86+, 88+	80
Bill :	26 (3), 26.5, 27 (5), 28, 29	26

The birds from central Nepal tend somewhat towards the eastern race *melanotus* in having a little more black on the upper side than do specimens from the western Himalaya. The spotting on the underside does not seem to be a good taxonomic character. While the western Himalayan birds are generally with more spots than those from the eastern Himalaya, this difference is appreciable only in a series and only on an average ; and individual variation of this character in the western birds is very great.

Eastern Nepal has been included within the range of the eastern subspecies *F. f. melanotus* Hume by Baker (1928, p. 411), followed by Peters (1934, p. 69) and Ripley (in press). Although it may possibly occur there, I am unable to trace any authentic record.

*114. **Francolinus pondicerianus interpositus** Hartert. Northern Grey Partridge.

The only post-Hodgsonian record of the Grey Partridge from Nepal is due to Rand & Fleming (1957, p. 60). They found it in the west-central tarai in February. Ripley's (1950b, p. 366) specimen was actually taken in India across the south-western Nepali border.

*115. **Francolinus gularis** (Temminck). Swamp Partridge.

Rand & Fleming's (1957, p. 60) is the only record of this partridge from Nepal after Hodgson's. They found it in the western tarai in winter.

*116. **Perdix hodgsoniae hodgsoniae** (Hodgson). Tibetan Partridge.

We did not find the Tibetan Partridge in Nepal, nor did Scully (1879), or Ripley (1950b). Lowndes (1955, p. 37) recorded it from *c.* 4270 m. in Manangbhot, central Nepal, in July ; and Rand & Fleming (1957, p. 60) from *c.* 3960-4420 m. in west-central Nepal in winter.

*117. **Coturnix coturnix coturnix** (Linnaeus). Common Quail.

The Common Quail was not met with by us or by Ripley (1950b) in Nepal. Scully (1879, p. 350) reported it in October-December and March-April from the Nepal Valley, in November from the Nawakot district, and in December from the plains. Rand & Fleming (1957, p. 60) found it in the western and west-central tarai in winter.

*118. **Coturnix coromandelica** (Gmelin). Blackbreasted, or Rain Quail.

*119. **Coturnix chinensis chinensis** (Linnaeus). Bluebreasted Quail.

*120. **Perdicula asiatica** (Latham) subsp. ? Jungle Bush Quail.

The records of the occurrence of these three quails in Nepal are based on Hodgson's collection (Gray & Gray, 1846, p. 128) only.

*121. **Arborophila torqueola torqueola** (Valenciennes). Common Hill Partridge.

Although recorded from the hills round the Nepal Valley (Scully, 1879, p. 349 ; Smythies, 1950, p. 518 ; Proud, 1955, p. 71 ; Rand & Fleming, 1957, p. 61), from west-central Nepal (Rand & Fleming, loc. cit.), and from the Mai Valley, eastern Nepal (Stevens, 1925c, p. 889), the Common Hill Partridge was not found by us or by Ripley (1950b).

122. **Arborophila rufogularis rufogularis** (Blyth). Rufousthroated Hill Partridge.

DUN : Hitaura : 1 ♂, 1 chick in down (May 26, 27).

The Rufousthroated Hill Partridge was found by us once in the Nepal Valley on Phulchauki Range above Godavari at *c.* 1980 m. early in May, and on a very few occasions in the central dun in May-June.

Ripley (1950b, p. 367) noted it as a common bird in western Nepal at *c.* 1525 m., but Rand & Fleming (1957, p. 61) ' seldom came across it in western ' and west-central Nepal at *c.* 915-1825 m.

The chick in down has a broad reddish brown stripe on each side from the forecrown passing above the eyes, including the sides of the crown, to nape, the stripes of the two sides meeting anteriorly on the forecrown. Its ear coverts and an indistinct collar are black, and the remainder of the upper plumage chocolate brown. On the underside, it has the chin, throat, and upper breast brownish cream, the breast and flanks chocolate brown but paler than in the upper plumage, and the abdomen brownish cream.

Measurements : 1 ♂ : Wing 138, tail 53+, bill 23.

[**Galloperdix spadicea spadicea** (Gmelin). Red Spurfowl.

Although the Red Spurfowl has been mentioned as occurring in the Nepal tarai (Murray, 1890, p. 547, followed by Baker, 1928, p. 358 ; Peters, 1934, p. 106 ; and Ripley, in press), I am unable to trace any definite record of its occurrence there. It is however, likely to be found in the western Nepal tarai.]

*123. **Ithaginis cruentus cruentus** (Hardwicke). Nepal Blood Pheasant.

Scully (1879, p. 343) reported having seen only snared birds. Lowndes (1955, p. 37) observed it at *c.* 3660 m. in Mananghbot, central Nepal, in summer. Biswas (1960a) found it fairly common in Khumbu (*c.* 3660-4270 m.), eastern Nepal, during February-May.

*124. **Tragopan satyra** (Linnaeus). Crimson Horned Pheasant.

Meleagris Satyra Linnaeus, 1758, Syst. Nat., 10th ed., **1** : 157. (Bengal.)[1]

The Horned Pheasant was not found by us. Scully (1879, p. 343) had specimens brought to him from the hills north of the Nepal Valley. Ripley (1950b, p. 367) saw only feathers at *c.* 2740 m. in eastern Nepal in winter. Rand & Fleming (1957, p. 61) found it in the Kali Gandak Valley, west-central Nepal, at *c.* 2740 m. in winter. Biswas (1960a) recorded it in the Dudh Kosi and Hongu Valleys, eastern Nepal, at *c.* 2740-3050 m. in April and June.

Gray & Gray (1846, p. 125) listed also the Western Horned Pheasant, *Tragopan melanocephalus* (J. E. Gray), among Hodgson's collection from Nepal. However, Ogilvie-Grant (1893, pp. 274-275) did not include any specimen of that species from Nepal, nor has it ever been recorded east of Kumaon.

*125. **Pucrasia macrolopha nipalensis** Gould. Nepal Koklas Pheasant.

The Koklas Pheasant was not found by us or by Ripley (1950b). Scully (1879, p. 344) had specimens brought to him from western Nepal ' not far from the snows '. Rand & Fleming (1957, p. 63) collected specimens in the Kali Gandak Valley, west-central Nepal, at *c.* 2435-2740 m. in winter.

*126. **Lophophorus impejanus** (Latham). Monal Pheasant.

We did not come across the Monal Pheasant in Nepal, nor did Ripley (1950b). Scully's (1879, p. 342) specimens were brought for him from ' the interior of Nepal at higher elevations '. In northern-central Nepal, it was found by Smythies (1948, p. 442) at *c.* 3350-4570 m. in autumn, and by Proud (1952a, p. 366) at *c.* 3350-3660 m. in spring, both in the Gandak-Kosi watershed ; and by Polunin (1955, p. 895) at *c.* 2740-4880 m. in the Langtang Valley in summer. Rand & Fleming (1957, p. 62) reported it from the Kali Gandak Valley, west-central Nepal, at *c.* 2590 m. in December. Biswas (1960 a) found it in Khumbu, eastern Nepal, at *c.* 3810-4270 m. during February-May.

127. **Gallus gallus murghi** Robinson & Kloss. Red Junglefowl.

TARAI : Simra : 2 ♀♀ (March 4, 5). BHABAR : Amlekhganj : 1 ♂ (March 10). DUN : Hitaura : 2 ♂♂, 1 juv. ♂, 4 ♀♀, 1 subad. ♀, 1 juv. ♀ (May 12—June 5, 22).

The Red Junglefowl is common in the tarai, bhabar, and dun of central Nepal.

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[1] Peters (1934, p. 109), followed by Ripley (in press), stated that the type locality Bengal was an error, because ' the drawing on which Edward's plate was based was probably made from a specimen from Nepal '. This assumption seems to me to be too far fetched, especially because Nepal was almost ' terra incognita ' in the 18th century, while this bird has always occurred in the Darjeeling district of Bengal.

The subadult female specimen (Hitaura, May 12) is downy on the chin and throat, and smaller in size, but otherwise similar to the adult.

The juvenile male and female specimens (Hitaura, June 22) are similar in coloration, except that the male has the nape concolorous with the crown, and has a few blackish feathers on the breast and abdomen. Both of them have the chin and throat white. The male has no spur.

Measurements :

	Wing	Tail	Bill from the anterior edge of nostril
3 ♂♂:	226+, 227+, 231	300, 327,—	14, 15, 15+
6 ♀♀:	192, 193 (2) 195 200, 202	135+, 137, 139, 144, —(2)	13, 13.5 (2), 14 (3)

*128. **Lophura leucomelana hamiltoni** (J. E. Gray). Whitecrested Kalij Pheasant.

Phasianus hamiltoni J. E. Gray, 1829, in Griffith, Anim. Kingd. **8** (Aves, 3) : 27. (India=Simla, according to Baker, 1922e, p. 842.)[1]

The Whitecrested Kalij Pheasant was not found in Nepal by Scully (1879) or Ripley (1950b), or by us. Rand & Fleming (1957, p. 63), however, observed a flock in west-central Nepal at *c.* 915 m.

129. **Lophura leucomelana leucomelana** (Latham). Nepal Kalij Pheasant.

DUN : Hitaura : 1 ♂, 1 subad. ♂, 1 ♀ (May 21—June 2). MARKHU VALLEY : Deorali : 1 ♂ (April 30). NEPAL VALLEY : Thankot, crest of Chandragiri above Thankot : 1 ♂, 1 subad. ♂ (April 3, 18).

This kalij is found fairly commonly both in the dun and the Nepal Valley on the surrounding ranges. We usually saw it in the early mornings and late afternoons when it came out in the open parts of the forests to feed. It also appeared for feeding, irrespective of time of day, immediately after showers during early monsoon when insects also came out in great abundance. Biswas (1960a) observed a pair of this kalij a little below 3660 m. in Khumbu, eastern Nepal, in May — the highest recorded elevation for this bird.

The adult female specimen (Hitaura, May 21) has a small crest consisting of only a few feathers, concolorous with the back, but pale (white) shafted. The early June birds (1 ad. and 1 subad.♂) are very worn and their body plumage is in moult.

April birds were breeding. One male (April 18) had the right testis 17 × 11 mm., and the left 16.5 × 9 mm.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	230, 232	255+, 305	37,—
1 ♀ :	208	208	35

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[1] There is no definite evidence to set aside Baker's designation of the type locality, which Kinnear (Peters, 1934, p. 112, followed by Ripley, in press) did on mere conjecture that ' the type probably came from Nepal '.

*130. **Lophura leucomelana melanota** (Hutton). Blackbacked Kalij Pheasant.

The Blackbacked Kalij was first recorded for Nepal by Stevens (1925c, p. 887) who found it in the Mai Valley, eastern Nepal. I have not been able to trace any other report of its occurrence in Nepal.

*131. **Catreus wallichii** (Hardwicke). Cheer Pheasant.

The Cheer Pheasant was not found by us or by Ripley (1950b). Scully (1879, p. 345) saw only snared birds from the hills north of the Nepal Valley. Rand & Fleming (1957, p. 63) found it in the Kali Gandak Valley, west-central Nepal, at *c.* 2130 m. in December.

132. **Pavo cristatus** Linnaeus. Indian Peafowl.

DUN : Hitaura : 1 ♂, 1 subad. ♂, 1 juv. ♂, 1 fledgling ♂, 1 fledgling ♀ (June 5-9, July 6).

The Peafowl is common in the central dun. It is usually found in dense riverine jungles, tall grass jungles as well as in the cultivated land close by. Scully (1879, p. 342) found it only in the central bhabar, and Rand & Fleming (1957, p. 63) recorded it up to *c.* 305 m. only. Curiously, it is not listed in Hodgson's earlier collection from Nepal (Gray & Gray, 1846), nor shown in Ripley's (1950b) list.

Both my adult and subadult male specimens (June 7, 9) are worn and have their body feathers moulting, the latter being a second year bird. The adult female (June 6) is also worn and moulting. The juvenile male (June 5) has the tail in moult, and the fledglings (July 6) are undergoing a general moult.

Measurements :

	Wing	Tail	Bill	Train
1 ♂ :	458	483	50	1600
1 ♀ :	374+	300	44	—

Marien (1951) utilized the specimens under report here for his studies.

(To be continued)

Some useful and medicinal plants of Naini Tal in the Kumaon Himalayas

BY

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INTRODUCTION

Naini Tal, a beautiful health resort in the Kumaon Himalayas, is situated at latitude 29°24′ north and longitude 79°28′ east, and is the summer capital of Uttar Pradesh. Studies on the flora and vegetation of this part have already been made by the author and published separately (1958, 1959). While making floristic studies some interesting observations on the medicinal and other uses of the plants of this area were made by the author ; they are being described in these pages.

Plants from this area were collected in their flowering seasons and are preserved in the herbarium of the Government College, at Naini Tal.

LIST OF THE PLANTS

Ranunculaceae

1. **Thalictrum foliolosum** DC.

Name : Barmat (Kumaon), Pilijari (Hindi). Habit : Perennial herb. Flowers : White-purple, July.

Uses : The roots are used in collyrium, opthalmia, piles, and skin diseases.

2. **Delphinium denudatum** Wall.

Name : Judwar (Hindi). Habit : Annual herb. Flowers : Blue, April-June.

Uses : The roots are used as a cure for cough and diseases of blood.

3. **Paeonia emodi** Wall.

Name : Udsalap (Hindi). Habit : Perennial herb. Flowers : Blue, April-June.

Uses : The tubers are used in uterine disorders. Infusion of the flowers is used in diarrhoea.

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[1] Present address : French Institute, Pondicherry.

Menispermaceae

4. **Cissampelos pareira** Linn.

Name : Harjori (Hindi). Habit : Climbing herb. Flowers : Green, June-July.

Uses : The roots are used in affections of the bladder. The leaves are used externally in sores and abcesses.

5. **Berberis lycium** Royle

Name : Chitra, Daruhaldi (Hindi), Kilmora (Kumaon). Habit : Tall erect shrub. Flowers : Yellow, April.

Uses : The extract of the bark gives *rasot* which is sold in the market and is used as a cure for jaundice, diseases of the spleen, intestines, and eye. Locally this extract mixed with rose-water is used as a medicine in eye sores.

6. **Berberis aristata** DC.

Name : Kingora, Kilmora (Kumaon), Daruhaldi (Hindi). Habit : Erect shrub. Flowers : Yellow, May-June.

Uses : The extract of the bark gives *rasot* and is used for the same purpose as the other species.

Cruciferae

7. **Capsella bursa-pastoris** Medic.

Habit : Annual erect herb. Flowers : White, April-October.

Uses : The plant is used in diarrhoea and dropsy. It lowers the blood pressure, and checks haemorrhage.

Violaceae

8. **Viola canescens** Wall.

Name : Thungtu (Kumaon), Banefsha (Hindi). Habit: Annual herb. Flowers : Blue, April-November.

Uses : The flowers are sold in the market as *gulbanefsha* and are used for curing fever, bronchitis, and asthma. The syrup of the flowers is used in Yunani medicine for the same purposes. Oil prepared from the plant is also used medicinally.

Polygalaceae

9. **Polygala crotalarioides** Buch.-Ham.

Habit : Perennial herb. Flowers : Purple, April-October.

Uses : The plant is used in catarrhal affections and is chewed to expel phlegm from the throat and provoke coughing.

Malvaceae

10. **Malva rotundifolia** Linn.

Name : Khubasi, Sonchala (Hindi). Habit : Annual herb. Flowers : Pale lilac, July-October.

Uses : The leaves are used in dysentery and nephritic troubles, in piles and skin diseases.

Geraniaceae

11. **Geranium wallichianum** Sweet

Name : Mamiran (Hindi). Habit : Perennial erect herb. Flowers : Purple, July-September.

Uses : The rootstock of the plant is used in eye troubles and as a cure for toothache. It is also used as a substitute for *Coptis teeta* Wall.

12. **Geranium nepalense** Sweet

Name : Bhand (Kumaon). Habit : Perennial diffused herb. Flowers : Pink, May-September.

Uses : The herb is used for renal troubles.

13. **Geranium lucidum** Linn.

Habit : Annual diffused herb. Flowers : Pink, May-August.

Uses : The plant is used as a diuretic and astringent.

14. **Oxalis acetosella** Linn.

Name : Amrul, Chalmori (Kumaon). Habit : Perennial pubescent herb. Flowers : Purple, June-July.

Uses : The herb is used as refrigerant and forms a drink, in fever. The leaves are used as salad.

15. **Oxalis corniculata** Linn.

Name : Amêlda, Tipatia (Kumaon). Habit : Annual procumbent herb. Flowers : Yellow, April-November.

Uses : The plant is used as an appetiser, and in dysentery, diarrhoea, and fever. Fresh leaves in the form of a poultice are applied to inflamed parts.

Rutaceae

16. **Zanthoxylum alatum** Roxb.

Name : Timru (Kumaon), Têjphal (Hindi). Habit : Prickly shrub. Flower : Yellow, April-June.

Uses : The seeds are used in abdominal troubles, and in diseases of eye, ear, and in leucoderma. Locally the seeds are used for curing toothache and removing foul smell from the mouth. The twigs form the tooth brush used locally.

17. **Skimmia laureola** Thunb.

Name : Nehar (Kumaon), Gurlpatta (Garhwal). Habit : Erect shrub. Flowers : Yellow, April-May.

Uses : The leaves and flowers are aromatic and are used as incense locally.

Celastraceae

18. **Euonymus tingens** Wall.

Name : Konkon (Kumaon), Bhambéli (Hindi, Garhwali). Habit : Small tree. Flowers : Yellow, April-June.

Uses : The plant is a gastro-intestinal stimulant and increases the flow of bile and other secretions. The bark is used in eye diseases.

19. **Rhamnus virgatus** Roxb. syn. *Rhamnus dahuricus* Pall.

Name : Chédul (Kumaon), Chanda (Hindi). Habit : Spinous shrub. Flowers : Green, April.

Uses : The fruits are emetic and purgative and are used in affections of the spleen.

Sapindaceae

20. **Aesculus indica** Coleb.

Name : Pângar (Kumaon). Habit : Tree. Flowers : White-yellow, April-May.

Uses : The fruits are given to horses in colic, and are eaten in times of scarcity. Oil from the seeds is used in rheumatism.

Anacardiaceae

21. **Rhus chinensis** Miller syn. *Rhus semialata* Murray

Name : Dhamili (Hindi). Habit : Small tree. Flowers : Pale yellow, green, April-June.

Uses : The fruits are used in colic and diarrhoea.

Coriaraceae

22. **Coriara nepalensis** Wall.

Name : Makol (Kumaon), Masuri (Hindi). Habit : Glabrous shrub. Flowers : Green, March-April.

Uses : The leaves are used as a purgative.

Leguminaceae

23. **Crotalaria sericea** Retz.

Name : Jhun-jhunia (Hindi). Habit : Silky pubescent shrub. Flowers: Yellow, February-March.

Uses : The plant is used for scabies.

24. **Melilotus alba** Lamk.

Name : Aspurk (Hindi). Habit : Annual herb. Flowers : White, June-September.

Uses : The plant is used externally for fomentation in pain. The fruits are carminative and useful in leucoderma.

25. **Desmodium tiliaefolium** Don.

Name : Chamlai (Kumaon). Habit : Tall erect shrub. Flowers : Pale lilac, July-October.

Uses : The root is used as a diuretic and in bilious complaints.

26. **Moghania strobilifera** (Linn.) St. Hil. ex Jacs. syn. *Flemingia strobilifera* R.Br.

Name : Kasraut (Hindi). Habit : Spreading shrub. Flowers : Red, August-October.

Uses : The roots are used to induce sleep and relieve pain with no ill effect. The leaves are used as a vermifuge.

27. **Lathyrus aphaca** Linn.

Name : Jangli matar (Hindi). Habit : Annual herb. Flowers : Yellow, April-May.

Uses : The seeds are used as green peas when young, but when ripe are narcotic and produce headache.

Rosaceae

28. **Prinsepia utilis** Royle

Habit : Spinous shrub. Flowers : White, December-April.

Uses : The seeds are used locally to extract oil which is used for application in rheumatism and pains from over-fatigue.

29. **Geum urbanum** Linn.

Habit : Perennial herb. Flowers : Yellow, May-July.

Uses : The herb is used in fevers, and is excellent cardiac sudorific in chills.

30. **Potentilla nepalensis** Hook. f.

Name : Rattanjot (Hindi). Habit : Perennial herb. Flowers : Red, April-September.

Uses : The ashes of the roots mixed with oil are used for curing burns.

31. **Potentilla fulgens** Wall.

Name : Bajra-danti (Garhwali, Kumaon). Habit : Perennial herb. Flowers : Yellow-orange, August-October.

Uses : The roots are said to strengthen gums and teeth.

32. **Agrimonia eupatorium** Linn.

Habit : Perennial herb. Flowers : Yellow, July-October.

Uses : The roots are astringent and are used in cough and diarrhoea. The leaves are used as a vermifuge.

33. **Pyracantha crenulata** (Don.) Roemer syn. *Crataegus crenulata* Roxb.

Name : Ghingaru (Kumaon, Garhwal). Habit : Large spiny shrub. Flowers : White, April-May.

Uses : The plant is not used medicinally, but the wood is valued for making walking sticks.

34. **Cotoneaster microphylla** Wall.

Habit : Procumbent much-branched shrub. Flowers : White-pink, April.

Uses : The stolons of this plant are astringent.

35. **Fragaria nubicola** Lindl. syn. *Fragaria vesca* auct. non Linn.

Habit : Perennial herb. Flowers : White, May.

Uses : The leaves are diuretic and are used in diarrhoea and affections of urinary organs. The fruit is astringent and diuretic.

36. **Rosa brunonii** Lindl. syn. *Rosa moschata* Mill.

Name : Kunja (Kumaon, Garhwal). Habit : Climbing prickly shrub. Flowers : White, April.

Uses : The flowers are useful in diseases of the eye and can be used like cultivated rose for all purposes.

Saxifragaceae

37. **Bergenia ligulata** (Wall.) Endl. syn. *Saxifraga ligulata* Wall.

Name : Silpharwa (Kumaon), Silphar, Pakhanbêd (Hindi). Habit : Perennial shrub with stout rootstock. Flowers : White-pink, April-May.

Uses : The rhizome is a renowned remedy in fevers and for removing gravel from the intestines and bladder. It can also be used as diuretic, astringent, and in spleen enlargement, diseases of liver, lungs, and chest.

Umbelliferae

38. **Bupleurum falcatum** Linn.

Habit : Perennial herb. Flowers : Yellow, July-August.

Uses : The roots are used in liver troubles and as a diaphoretic.

39. **Hydrocotyle javanica** Thunb.

Habit : Prostrate herb. Flowers : Yellow-green, July.

Uses : The plant is used in diseases of skin and blood.

40. **Hedera nepalensis** K. Koch syn. *Hedera helix* auct. non Linn.

Name : Bânda (Kumaon), Mithiari (Jaunsar). Habit : Climbing shrub. Flowers : Green, September-October.

Uses : The leaves are used for fomentation in glandular enlargement. Infusion of the berries is used in rheumatism.

Rubiaceae

41. **Galium aparine** Linn.

Habit : Trailing herb. Flowers : White-green, July-October.

Uses : The plant is diuretic, refrigerant, and alterative. It has been reported to reduce arterial pressure to 50% in a dog without slowing the pulse.

42. **Galium rotundifolium** Linn.

Habit : Trailing herb. Flowers : White-green, June-August.

Uses : The plant is used in sore throat and chest complaints.

43. **Rubia cordifolia** Linn. var. **munjista** Miquel syn. *Rubia cordifolia* Linn. p. p.

Name : Manjith (Hindi). Habit : Climbing herb. Flowers : Red, July-October.

Uses : The roots are useful in eye sores, liver complaints and spleen enlargement. The plant is also used in rheumatism, pleurisy, and other chest complaints.

Valerianaceae

44. **Valeriana jatamansi** Jones syn. *Valeriana wallichii* DC.

Name : Shumeo (Kumaon), Tagar (Hindi). Habit : Perennial herb. Flowers : White-pink, March-May.

Uses : The roots are aromatic and used in diseases of eye, blood, liver, spleen, and nervous system. Bath of valerian is useful in rheumatism.

Compositae

45. **Solidago virga-aurea** Linn.

Habit : Annual herb. Flowers : Yellow-pink, August.

Uses : The dried plant is used in dropsy.

46. **Gnaphalium luteo-album** Linn.

Habit : Erect softly woolly herb. Flowers : Yellow, June-August.

Uses : The leaves of the plant are used as an astringent and vulnerary. The tomentum below the surface of the leaves is used as tinder.

47. **Siegesbeckia orientalis** Linn.

Name : Litchkura (Hindi). Habit : Annual herb. Flowers : Yellow, September-October.

Uses : The plant is used in fevers, rheumatism, and renal colic. Externally it is applied to ulcers and ringworms.

48. **Bidens biternata** (Lour.) Merr. & Sherff. syn. *Bidens pilosa* Linn. p. p.

Habit : Annual herb. Flowers : White-yellow, September-October.

Uses : The plant is used in eye diseases. The roots are used in toothache.

49. **Galinsoga parviflora** Cav.

Habit : Annual herb. Flowers : White-yellow, January-December.

Uses : The plant is useful against nettle stings, when rubbed against the body.

50. **Gerbera lanuginosa** Benth.

Habit : Annual herb. Flowers : Pink, March.

Uses : White cotton-like coating on the undersurface of the leaves is used as tinder and for stanching wounds in times of emergency in the forest.

51. **Artemisia nilagirica** (Clarke) Pamp. syn. *Artemisia vulgaris* auct. non Linn.

Habit : Shrub-like herb. Flowers : Green-yellow, August-October.

Uses : The plant is used as a vermifuge. The leaves and flower tops are used in asthma.

52. **Emilia sonchifolia** DC.

Habit : Annual herb. Flowers : Purple, August-October.

Uses : The juice of the plant is considered as cooling as rose-water.

53. **Taraxum officinale** Wigg.

Name : Dudhli (Garhwal). Habit : Perennial herb. Flowers : Yellow, March-November.

Uses : The roots are used as diuretic and in complaints of the liver, kidneys, and digestive organs.

54. **Lactuca scariola** Linn.

Name : Kahu (Hindi). Habit: Annual herb. Flowers : Yellow, March-November.

Uses : The plant is used in bronchitis and asthma.

55. **Sonchus arvensis** Linn.

Name : Sadhi (Hindi). Habit : Succulent herb. Flowers : Yellow, August-September.

Uses : The plant is used as a diuretic and in fevers.

56. **Eclipta prostrata** Linn. syn. *Eclipta alba* Hassk.

Name : Bhargra (Hindi). Habit Herb, roughly pubescent. Flowers : August-September.

Uses : Plant is useful in hepatic and spleen troubles, externally it is applied for diseases of the skin.

Ericaceae

57. **Lyonia ovalifolia** (Wall.) Drude syn. *Pieris ovalifolia* D. Don.

Name : Ayar (Kumaon, Garhwal). Habit : Small tree. Flowers: White, May-June.

Uses : The leaves are poisonous to goats and sheep and are used to kill insects. Infusion of the plant is useful in skin diseases.

Myrsinaceae

58. **Myrsine africana** Linn.

Name : Ghani (Kumaon), Rikhdalmi (Garhwal). Habit : Small shrub. Flowers : Green, March-May.

Uses : The fruits are sold in the market as *baibharang* and are used as vermifuge and cathartic.

Styraceae

59. **Symplocos chinensis** (Lour.) Druce. syn. *Symplocos crataegoides* Buch.-Ham.

Name : Lodh (Kumaon). Habit : Small tree. Flowers : White, April-June.

Uses : The leaves are used as an astringent in diarrhoea.

Oleaceae

60. **Jasminum officinale** Linn.

Name : Jai (Kumaon), Chambeli (Hindi). Habit : Shrub. Flowers : White, May-July.

Uses : The flowers are used in diseases of heart, skin, and blood.

61. **Jasminum grandiflorum** Linn.

Name : Chambéli (Kumaon). Habit : Shrub. Flowers : White-purple, May-September.

Uses : The juice of the leaves is used to soften corns between the toes. Oil from the leaves is also used medicinally in skin diseases.

62. **Jasminum humile** Linn.

Name : Pilijai (Kumaon, Hindi). Habit : Shrub. Flowers : Yellow, May-October.

Uses : The leaves are used for the same purposes as the other species of jasmine.

63. **Fraxinus floribunda** Wall.

Name : Angu (Kumaon). Habit : Tree. Flowers : Green, April-May.

Uses : The bark is used as a laxative and an astringent.

Asclepiadaceae

64. **Cryptolepis buchanani** Roem. & Schult.

Name : Dudhi-bél (Kumaon). Habit : Twining herb. Flowers : Purple, April-June.

Uses : The plant is used for curing rickets of children.

Gentianaceae

65. **Swertia chirata** Buch.-Ham.

Name : Chirata (Kumaon, Hindi). Habit : Herb. Flowers : Yellow-green, September-November.

Uses : The dried twigs are used as a remedy in malarial and other fevers.

Solanaceae

66. **Solanum nigrum** Linn.

Name : Makoi (Hindi). Habit : Annual herb. Flowers : White, June-October.

Uses : The leaves are used in diseases of the liver. Paste of the green leaves is used in ringworm disease.

67. **Solanum indicum** Linn.

Name : Bhatkatya (Hindi). Habit : Shrub. Flowers : Blue, May-October.

Uses : The juice of the leaves is given to stop vomiting.

68. **Solanum xanthocarpum** Schrad. & Wendl.

Name : Kataili, Satyanashi (Hindi). Habit : Diffused shrub. Flowers : Blue, May-October.

Uses : The roots are used in cough, asthma, and catarrhal fevers. Fumigation with the vapours of burning seeds is a cure for toothache.

69. **Nicandra physalodes** Gaertn.

Habit : Annual herb. Flowers : Blue, July-September.

Uses : The plant is used as a diuretic.

70. **Datura stramonium** Linn.

Name : Dhatura (Kumaon). Habit : Annual herb. Flowers : White, June-October.

Uses : The leaves are used as a cure for asthma. The seeds are narcotic.

Scrophulariaceae

71. **Verbascum thapsus** Linn.

Name : Gidartambaku (Garhwal, Kumaon). Habit : Hairy annual herb. Flowers : Yellow, May-September.

Uses : The dried leaves and flowers are smoked for curing asthma.

Labiatae

72. **Origanum vulgare** Linn.

Name : Sahtra (Hindi). Habit : Annual herb. Flowers : Pink, July-September.

Uses : The leaves are used as a blood purifier.

73. **Nepeta elliptica** Royle

Name : Tukhammalanga (Hindi). Habit : Annual herb. Flowers : Blue, July-September.

Uses : Infusion of seeds in cold water is useful in dysentery.

74. **Ajuga bracteosa** Wall.

Name : Rathpatha (Kumaon). Habit : Annual hairy herb. Flowers : Blue, April-October.

Uses : The plant is anthelmintic and purgative and used in fever and skin diseases.

Plantaginaceae

75. **Plantago major** Linn.

Name : Luhuriya (Hindi). Habit : Perennial herb. Flowers : Green, July.

Uses : The seeds are laxative and used in dysentery. The roots and leaves are used against intermittent fevers.

Amaranthaceae

76. **Achyranthes bidentata** Bl.

Name : Chirchita (Kumaon), Apamarg (Hindi). Habit : Annual herb. Flowers : Green-purple, May-October.

Uses : The plant is used as a diuretic in renal troubles. The ashes of the plant are rich in potassium and are used in curing asthma and cough.

Polygonaceae

77. **Polygonum plebejum** R.Br.

Name : Raniphul (Hindi). Habit : Annual herb. Flowers : Pink, May-October.

Uses : The plant is used in pneumonia.

78. **Fagopyrum cymosum** Meissn.

Name : Banagal (Kumaon, Garhwal). Habit : Annual herb. Flowers : White, July-September.

Uses : The grains of the plant are used in diarrhoea and in colic. The leaves are used as a vegetable.

79. **Rumex nepalense** Spreng.

Name : Bhilmora (Kumaon). Habit : Annual herb. Flowers : Green-red, May-October.

Uses : The leaves are used in colic.

Lauraceae

80. **Cinnamomum tamala** Nees

Name : Dalchini (Garhwal, Kumaon), Tejpat (Hindi). Habit : Small tree. Flowers : White, February-May.

Uses : The bark and leaves are used as a condiment and medicinally in rheumatism and diarrhoea.

Elaeagnaceae

81. **Elaeagnus umbellata** Thunb.

Name : Geowain (Kumaon). Habit : Thorny shrub. Flowers : White, April.

Uses : The flowers are used as an astringent and the seeds in pulmonary affections.

82. **Hippophae rhamnoides** Linn. syn. *Hippophaë salicifolia* Don. Servettez.

Name : Chu (Kumaon). Habit : Thorny shrub. Flowers : Orange, June-July.

Uses : The fruits are used in pulmonary affections.

Loranthaceae

83. **Viscum album** Linn.

Name : Banbanda (Kumaon). Habit : Parasitic shrub. Flowers : Green, March-May.

Uses : The berries are used in enlargement of liver and spleen.

Santalaceae

84. **Osyris wightiana** Wall. ex Wight. syn. *Osyris arborea* Wall.

Name : Bakarja (Kumaon). Habit : Shrub. Flowers : Yellow, August-April.

Uses : Infusion of the leaves is used as powerful emetic.

Euphorbiaceae

85. **Andrachne cordifolia** Muell.-Arg.

Name : Bharti (Garhwal). Habit : Small shrub. Flowers : Green, May-September.

Uses : The plant is poisonous and kills cattle when browsed.

Urticaceae

86. **Cannabis sativa** Linn.

Name : Bhangla (Garhwal, Kumaon), Bhang (Hindi). Habit: Annual herb. Flowers : Green, July-August.

Uses : The leaves are intoxicating and the bark is used for hydrocele and other inflammations.

87. **Urtica parviflora** Roxb.

Name : Bitchu ghass (Kumaon, Garhwal). Habit : Annual herb. Flowers : Green, July-August.

Uses : The plant is used as a diuretic in nephritic troubles. Young leaves are made into a vegetable and taken as a cure for sciatica, rheumatism, and heart trouble.

88. **Girardinia heterophylla** Dcne.

Name : Bitchu ghass (Kumaon). Habit : Annual herb. Flowers : Green, February-April.

Uses : The leaves are astringent and are used as a remedy for scrofula.

Myricaceae

89. **Myrica esculenta** Ham. ex Don. syn. *Myrica nagi* Thunb.

Name : Kaiphal (Kumaon, Garhwal). Habit : Small tree. Flowers : Green, October-December.

Uses : The bark is anthelmintic and used in cholera. The fruits are edible.

Cupuliferae

90. **Quercus incana** Roxb.

Name : Ban, Banj (Kumaon, Garhwal). Habit : Tree. Flowers : Green, April-July.

Uses : The acorns are astringent and diuretic, and are used in asthma and diarrhoea.

Salicaceae

91. **Populus ciliata** Wall.

Name : Pahari-pipal (Kumaon, Garhwal). Habit : Tall tree. Flowers : Green, February-April.

Uses : The bark is used as a blood purifier.

Orchidaceae

92. **Satyrium nepalense** D. Don.

Name : Salabmisri (Hindi). Habit : Terrestrial herb. Flowers : Purple, July-August.

Uses : The pseudobulb of the plant is used as a tonic.

Scitaminaceae

93. **Roscoea procera** Rose.

Name : Sufedmusli (Hindi). Habit : Perennial herb. Flowers : Purple, July-August.

Uses : The roots are tuberous and are used as a tonic and in diseases of seminal debility.

94. **Hedychium spicatum** Buch.-Ham. var. **acuminatum** Wall.

Name : Kapur-kachri (Garhwal). Habit : Perennial herb. Flowers : White-pink, July-August.

Uses : The rootstocks are used in asthma, bronchitis, and as incense for burning.

Iridaceae

95. **Iris nepalensis** Don.

Habit : Perennial herb. Flowers : Lilac, April-June.

Uses : The roots are used as a diuretic.

96. **Iris kumaonensis** Wall. ex Don.

Habit : Perennial herb. Flowers : Lilac, June.

Uses : The roots and leaves of the plant are used in fevers.

Liliaceae

97. **Asparagus filicinus** Buch.-Ham.

Name : Kaunta (Kumaon), Satawar (Hindi). Habit : Perennial herb. Flowers : White, June.

Uses : The roots are tonic and used in chronic dysentery, dyspepsia, and diarrhoea.

Commelinaceae

98. **Commelina obliqua** Buch.-Ham.

Name : Kanjura (Kumaon). Habit : Annual herb. Flowers : Blue, July-August.

Uses : The roots are used in fever and bilious affections.

Filicales

99. **Dryopteris filix-mas** (Linn.) Schott. syn. *Aspidium filix-mas* Sw.

Uses : The plant is anthelmintic and is used to kill worms.

100. **Adiantum venustum** Don.

Uses : The fronds are emetic and are used as a decoction for chest and pulmonary affections.

101. **Botrychium ternatum** Sw.

Uses : The plant is used in healing cuts and wounds.

ACKNOWLEDGEMENTS

The author is deeply indebted to Prof. K. S. Bhargava, Head of the Botany Department, Government College, Naini Tal, for his kind help and encouragement.

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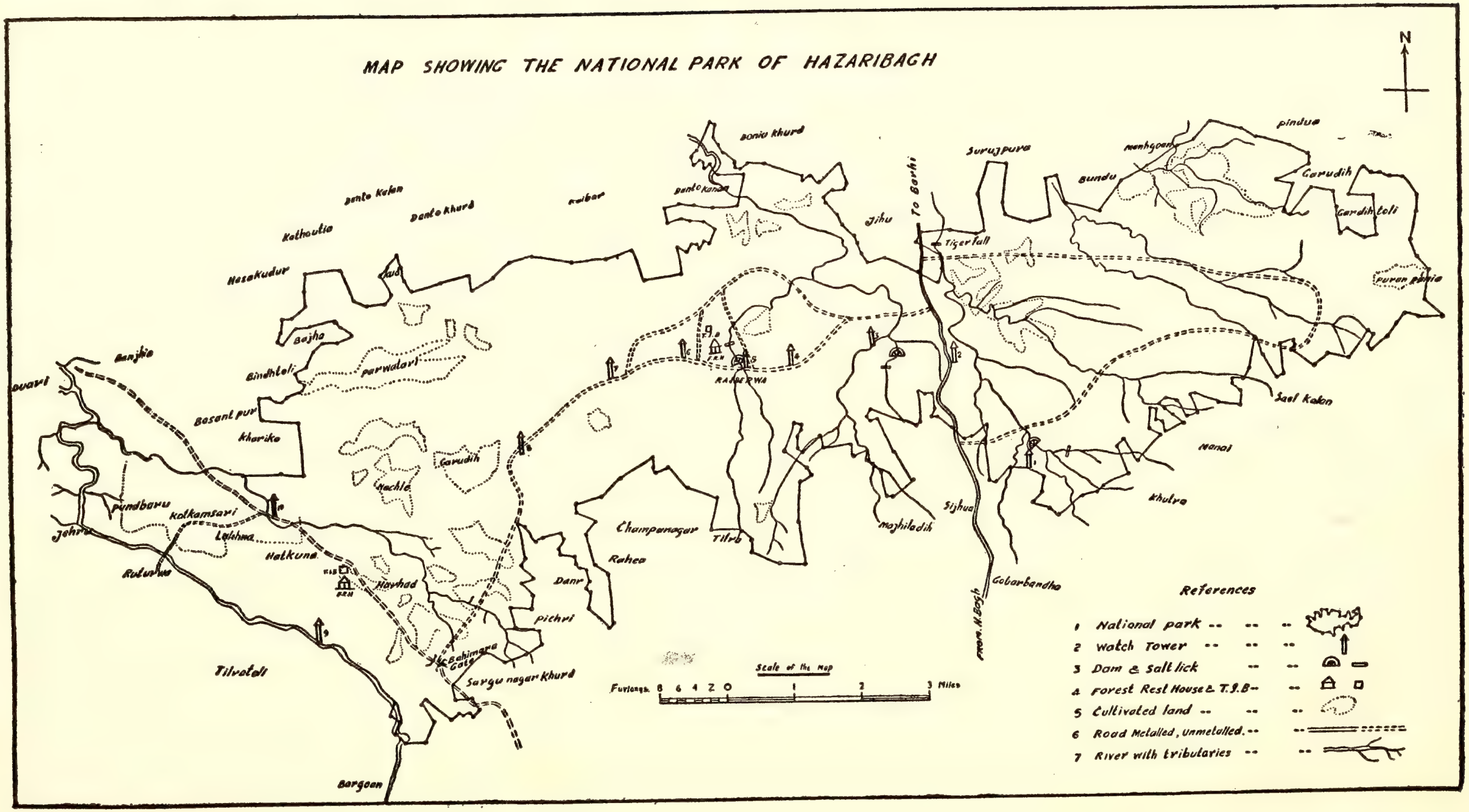


MAP SHOWING THE NATIONAL PARK OF HAZARIBAGH

N
Bonio khurd
Surujpura
menhgoan
pindua
Bundu
Garudih
Gardih toli
Puran Pania
Dento Kalan
Dento Khurd
Raibar
Dento Kanan
Kathoutia
Hesakudur
Bajha
Bindhtoli
Parwatari
Banjhio
ouari
Basant pur
Kharika
Garudih
Nachle
Jihu
To Barhi
Tiger fall
RAJDERWA
F.R.H
T.B
Saal Kalan
Nanal
Khutra
Sijhua
Majhiladih
Champanagar
Tilra
Rahea
Danr
Pichri
Gobarbandha
From H. Bagh
Pundbaru
Kolkamsari
Lalthua
Jehru
Rulurwa
Halkuna
Havhad
Bahimara Gate
Sargu nagar Khurd
Tilvateli
Bargoan
Scale of the Map
Furlongs 8 6 4 2 0 1 2 3 Miles
References
1 National park -- -- --
2 Watch Tower -- -- --
3 Dam & Salt lick -- --
4 Forest Rest House & T.J.B -- --
5 Cultivated land -- -- --
6 Road Metalled, unmetalled. -- --
7 River with tributaries -- --

A Cursory Ecological Survey of the Flora and Fauna of the Hazaribagh National Park (Bihar)

BY

JAMAL ARA

(*With a map*)

SYNOPSIS

An ecological survey of the Hazaribagh National Park in Bihar, carried out in two attempts, one from December 12 to December 22, 1959, and the other from January 8 to January 16, 1960, revealed a distinct correlation between forest types and the distribution of the fauna, in respect of both the larger animals and the birds. The survey was carried out by intensively sampling 20% of the area of the National Park in which all the forest types were represented. The results show that the population of both animals and birds is low; there being only some 60 species of birds and the larger mammals totalling about 300 individuals. In addition the fauna is very shy, and in spite of five years of protection has not shed its fear of man.

In the case of the Whitefaced Wagtail and the Blackheaded and Rufousbacked Shrikes, the sub-species can be easily separated in the field by sight alone. In these cases, therefore, trinomials have been used without specimens actually having been collected.

1. GENERAL

The idea of creating a National Park in Bihar was first mooted in December 1952, and the present site was tentatively suggested. This site at first was not considered ideal and several alternative sites were also explored. In the end, considering the factors of accessibility and the presence of a reasonable number of wild life, the present location was deemed to be the best. In 1953, therefore, a proposal was submitted to the State Government and the matter was also discussed at a meeting of the State Wild Life Board held in April 1954. In August 1954 the State Government issued an executive order creating a sanctuary only, with the intention of eventually converting it into a National Park after the policy in respect of National Parks had been decided by the Indian Board for Wild Life. In the same order Government sanctioned staff comprising one Assistant Game Warden of the rank of a Forest Ranger and 10 Game Guards. 2 Foresters were also sanctioned at a later date. The Divisional Forest Officer of the Hazaribagh Forest Division was appointed as the Game Warden.

The policy in respect of National Parks was decided at the meeting of the Indian Board for Wild Life held at Calcutta in February 1955, and some time later the Board also circulated model legislation for National Parks. But no action at all was taken in Bihar in respect of this area. Even though in all official and non-official descriptions it is called a National Park, the actual position is that it is only a sanctuary created by executive order. It appears that not even the Forest Department have taken any steps to persuade Government to convert it into a full-fledged National Park by enacting legislation. Until that is done the legal position is rather precarious.

Though the carrying of arms into the area is forbidden there is no legal sanction behind this order, and if anybody refuses to hand over his arms the forest staff have no powers to enforce it. Again shooting in self-defence is permitted by the law even inside sanctuaries and it is a wonder that nobody has as yet taken advantage of this lacuna. Another shortcoming is the lack of visible demarcation of the limits of the Park at the spot. The boundary where it coincides with natural features or roads etc. is clear, but elsewhere it is not possible to find out where the limits are. I understand that, when planned, the idea was to fence it all round with barbed wire so as to limit ingress or egress to recognised gates, but this has not been done so far. Whilst barriers have been erected on all the roads leading into it from the National Highway, there is nothing to prevent a poacher from entering on a jeep at places away from these barriers.

2. Location

The National Park is situated in the Hazaribagh district astride the Patna-Ranchi National Highway, between 7 and 11 miles (11 and 18 km.) from Hazaribagh town proceeding towards the Grand Trunk Road, which passes through Barhi, 22 miles (35 km.) north of Hazaribagh and 248 miles (400 km.) west of Calcutta. It comprises the old reserved forests of the Ramgarh Raj which were nationalised under the Bihar Land Reforms Act. These forests cover an area of 77 square miles or 20,000 hectares approximately, and are completely free from any kind of right whatsoever. Though these were reserved forests, yet the Ramgarh Raja had extensive shoots for himself, his guests, and British V.I.Ps. At a later date live tigers were also trapped for sale. A tiger trap used in those days is still to be seen, but is maintained merely as a curiosity. In the result, though ordinary persons could not shoot in this area, yet heavy shikar by the owner himself led to a steady depletion of the fauna. Also, poaching by villagers was not very strictly controlled.

3. AMENITIES

After conversion into a sanctuary the Forest Department undertook large scale construction work. Today there are about 40 miles (64 km.) of motorable gravel roads traversing the entire area. There are also 3 dams for storing water since there is a shortage of water in the hot weather. 10 Watch Towers strategically located provide vantage points for observation. There are two Forest Rest Houses and a 4-roomed Tourist Lodge. The rents are Rs. 6 per room per day in the Forest Rest House and Rs. 4 in the Tourist Lodge. Though a khansama is provided no foodstuffs are available with him. If, however, the raw materials are supplied he can turn out a meal, though the standard of cooking is not very high. Intending visitors will be well advised to carry foodstuffs with them and not depend on local supplies. The tariff of meals hung up in the Tourist Lodge is completely misleading as not a single item mentioned on it can ever be supplied by the khansama. Bed linen, mattresses, pillows, mosquito nets, and towels are provided; visitors have to carry only blankets.

4. TOPOGRAPHY

The longest axis of the Park lies east and west and extends on either side of the National Highway. The maximum length is 16 miles or 26 kilometres and the average is between 12 and 13 miles (19 km. to 21 km.). The width varies considerably from a maximum of 6 miles (9.5 km.) in the middle just west of the National Highway to a minimum of 1½ to 2 miles (2.4 to 3.2 km.) on both the eastern and the western extremities. Inside the Park itself there are few villages and none of them of any considerable extent, but the southwestern part over an area of approximately 9 to 10 square miles (2300 to 2900 hectares) is honeycombed with them.

Apart from this area there are also tiny patches of cultivation elsewhere, though none of them is more than an acre or two in extent. On the whole it is comparatively free from the dangers of illicit felling and poaching by villagers except on its fringes. In this connection it may be mentioned that the Government did not accept the proposal of the Forest Department to have a buffer zone 5 miles (8 km.) wide all along the boundaries of the Park and declare it a sanctuary.

The general slope lies from south to north, and both from the east and the west to the middle, the National Highway running through the trough of the area. The bench marks decrease from 1888 feet (575 m.) above sea-level at the boundary of the National Park in the south to 1511 feet (460 m.) at the northern end. The average slope from the east to the National Highway is greater, falling from over 1900 feet (575 m.) in the extreme east to the level of the Highway itself. West of the Highway the slope is not so marked and the watershed lies at approximately 1900 feet (580 m.) some 2 to 3 miles (3.2 km. to 4.8 km.) west of the Highway. From here the country slopes down to about 1750 feet (530 m.) and rises again to about 1900 feet (580 m.) in the extreme west. The highest point is a spot height 2086 feet (635 m.) above sea-level situated between the villages of Gurudih and Nachle in the extreme west approximately 8½ miles (13.6 km.) from the National Highway.

The general direction of flow of almost all the streams is from south to north and there are no streams penetrating the watershed lying west of the National Highway. Two drainage basins lie on either side of this watershed and they both flow south for quite some distance before meeting at a gap on the northern boundary. East of the Highway the area is not so well watered and there are only two perennial streams which unite and give rise to the Tiger Falls just short of the northern boundary about 2 furlongs (400 metres) west of the Highway.

The underlying strata are mostly shales, which crumble and weather easily but do not give rise to a rich soil. Shales in Bihar are invariably associated with a poor site quality for *Shorea robusta* and therefore, even at its peak, this area is not capable of any crop better than good Quality III Sal. Correspondingly, at no time will it be possible for this area to have many soft-fruited trees. Villagers or contractors do not usually fell *Ficus* trees, but even today the Park is very short of them. I could not see a single mango tree throughout the area and there were very few *Madhuca latifolia*

(Mahua) trees as well. This may perhaps account for the comparative paucity of bird species. The odd *Ficus* tree where it occurs always attracts large mixed hunting parties. For example, a lone *Ficus glomerata* tree near the Forest Rest House was always teeming with barbets, bulbuls, parakeets, and others.

The area has not been sub-divided into blocks and compartments, which renders locations extremely difficult to describe. The only fixed points are the roads and watch towers, and using them as reference points has not been found to be very satisfactory, but in the circumstances is the only way available for the purpose.

5. ECOLOGY

The forest type is B-3 Dry Peninsular Sal according to the classification of Champion with the general conditions more xerophilous. As a matter of fact there is a complete absence of evergreen species and even along the streams no evergreen patches exist. *Terminalia* trees are rather scarce and no *Michelia champaca* or *Anthocephalus cadamba,* the usual moist associates of Sal, were seen.

The Sal crop itself is entirely in the pole stage and no trees of 4 feet (1.21 m.) girth or above exist. The crop itself is remarkably uniform in age and averages 30-40 years. It appears to be the result of heavy selection fellings as there is no record of this area having been subject to extensive shifting cultivation within the last 50 years. In fact Hazaribagh district as a whole was never subject to shifting cultivation in a large degree at any time.

Due to the immature nature of the crop estimation of quality classes proved difficult, but the northern aspects carry a good Quality III crop whereas the southern aspects carry a poorer crop. The usual associate of Quality I Sal, *Clerodendrum infortunatum* was not seen at all.

The associates of Sal vary very widely, and even within a small area showed remarkable changes. Thus on the road leading from Watch Tower 4 to 5 the southern aspects had a very large proportion of *Boswellia serrata* (Salai) forming at places practically pure patches. Signs of heavy grazing in the past are provided by the presence of *Nyctanthes arbortristis* (Harsinghar). The northern aspects on this road have a large number of bushes of *Flemingia chappar,* indicative of a good site quality for Sal. In this area too the stream banks carry some *Eugenia heyneana* (Kat Jamun).

On the other hand along the Bahimar road the proportion of *Boswellia serrata* is very low, even on the southern aspects.

Generally speaking the conditions are more tropophilous than on the other road and *Bauhinia vahlii* is rather common, forming at places a pure bushy undergrowth.

The third road is the one leading from the Forest Rest House to the National Highway. Here the forest is a blend of the other two types described above, but on the whole tending towards xerophilous conditions. *Boswellia serrata* is present in much smaller numbers and there is an increase in the number of *Acacia catechu* (Khair) trees. Elsewhere the *A. catechu* is very isolated but here it can be found in small groups forming an association. Remarkably enough, however, the only large stream flowing here carries large numbers of *E. hyneana* both along the banks and on the islands.

The Sal appears to be in the stage of a precarious climax, the condition being comparable to that obtaining in the Baresand Block of the Palamau Forest Division though neither the flora nor the fauna is as rich as in that block. Here also any large scale opening of the canopy leads to a heavy invasion by *Heteropogon contortus* (Spear grass), completely inhibiting Sal regeneration and smothering any advance growth that is present. This is nowhere more evident than on the view strips being cut along the roadsides, where the fellings are almost in the nature of clear-fellings. The few Sal trees that have been left in these clearings, probably to serve as seed-bearers, are likely to suffer from excessive insolation whereas the chances of their inducing Sal regeneration are precisely nil. How far these fellings are ecologically desirable both for the flora and the fauna is extremely debatable. Floristically they are definitely introducing seral retrogression, and they do appear to have the effect of driving wild life more into the interior due to a lack of cover.

Based on these observations the following ecological subtypes can be distinguished:

TYPE A: A *Shorea robusta-Boswellia serrata* association confined to southern aspects, with the *B. serrata* occurring in pure patches on the drier and more exposed slopes. The shrubs here comprise *Nyctanthes arbortristis*, *Gardenia* spp., *Colebrookia oppositifolia*. The grass is invariably *H. contortus*. Large shrubs, and even small trees of *Flacourtia ramontchi* are found in this type, particularly near the tops of the ridges. The spines on it are persistent, and give evidence of heavy fellings in the past.

SUB-TYPE A1: Occurring on the Bahimar Road. In this sub-type the proportion of *B. serrata* is much reduced. Instead bamboos (*Dendrocalamus strictus*?) and on the higher slopes and ridges

Diospyros spp. are found. There is not much difference in the shrubby growth.

TYPE B: A Sal-*Terminalia* association occurring on the northern slopes and valley bottoms. In this type Sal of a superior quality is found, and the undergrowth is sharply divided. On the Bahimar Road there is a profusion of *Bauhinia vahlii* forming at places dense bushes and *Indigofera pulchella,* an indicator of a good site for Sal. The commonest *Terminalia* was *T. tomentosa* though *T. belerica* and *T. chebula* also occur as isolated trees. On the road from Watch Tower 4 to 5 the undergrowth is *Flemingia chappar,* and *Bauhinia vahlii* does not occur in such profusion.

TYPE C: Along nullahs and perennial streams. Some of the streams have a growth of *E. hyneana* and its associate is usually *Saccharum narenga* (in bloom). In the streams where *E. hyneana* is not found *Saccharum spontaneum* (?) and *S. narenga* occur.

A common feature of all types is the presence of *H. contortus* in varying degrees. Where the canopy is open or has been opened this grass has formed a dense impenetrable mat choking and suppressing all other kinds of vegetation. Sal regeneration is usually absent from all the types, and it is doubtful if any will be established until the canopy is allowed to close and the *H. contortus* wiped out.

A dangerous sign is the stray occurrence of *Lantana* sp. bushes. Since lantana also thrives where the canopy is open, a combination of *Lantana* and *H. contortus* will eventually wipe out every other kind of vegetation. This is all the more reason why fellings in this area should be carried out with great caution so as to avoid permanent gaps in the canopy. Even thinnings should not be heavier than grades B/C. Another danger is that of forest fires. Dry *H. contortus* is as inflammable as tinder, and during the hot weather can catch fire spontaneously. Whilst fire tracing of all view strips and roadside areas is done annually by early burning, it is well known that this is only poor insurance against hot weather fires. Early burning cannot be done beyond March, and after that there is enough time available before the monsoon breaks for the spear grass to grow up again. Forest fires in a National Park are disastrous from every point of view, particularly for the fauna. It may even lead to depletion by driving out the larger animals and ground game. It must be mentioned that during the landlord's ownership forest fires were an annual occurrence in this area. How far the position has improved, if at all, cannot be said as I could not gain access to the fire records of the Forest Department.

All in all the evidence leads to the conclusion that the entire area has been felled over in the past but not according to a properly drawn up working plan or scheme. The growth that is seen now is probably second growth forest. The presence of *Flacourtia ramontchi* in fair numbers confirms this conclusion because this tree is typical of second growth forests recovering from past maltreatment.

6. Sampling Methods

A preliminary reconnaisance of the area made it clear that the best results would be obtained by intensively sampling a percentage of the National Park rather than an overall survey through strips or small sampling units distributed over the entire area. Accordingly an area of more or less 15 square miles (4000 hectares) was selected at random and intensively sampled, i.e. 20% of the total area.

All roads, stream beds, and foot-paths were gone over more than once as also several cross country transects were run between well-defined landmarks or from one road to another or from one foot-path to another. Particular attention was paid to salt licks which showed signs of being in use, as also frequented water holes and drinking places as revealed by footprints and pug marks. Observations were carried out after dark as well, but due to the intense cold these had to be terminated by 9 p.m. After that hour it became physically impossible to stay out of doors. There was a deposit of hoar frost on several nights.

Counting of animals was done both from those actually seen and from footprints and pug marks. Duplication was avoided by not recording footprints observed in the vicinity of any area where any herd of animals had been actually seen. It must, however, be made clear that duplication of numbers in a survey of this nature cannot be eliminated completely, and some allowance has to be made for this fact. No attempt at counting birds was made and in their case information is given as very common, common, frequent, rare, etc. Of course, such birds of which only a few specimens were seen have the number given against them.

7. Distribution of Fauna by Forest Types

The maximum concentration of fauna within the area sampled lies in the valley between the Bahimar Road and the opposite hills, through the bottom of which runs an abandoned road. South of this valley the concentration is good though less than within the valley itself. This valley comprises Type B of the ecological sub-types listed above. In this valley a herd of Spotted Deer (*Axis axis*), Muntjac (*Muntiacus muntjak*) and a Tiger (*Felis tigris*) were observed. Though no Sambar (*Rusa unicolor*) were actually seen yet one herd was identified from its hoof-prints along water courses, as also from damage caused at night to a plantation of Arhar (*Cajanus indicus*) near the staff quarters. I estimate the numbers as spotted deer 10, muntjac 4, tiger 1, and sambar about 6. This area contains the largest numbers of Treepie (*Dendrocitta vagabunda*), Ring Dove (*Streptopelia decaocto*), Whitebellied Drongo (*Dicrurus caerulescens*), and Roseringed Parakeet (*Psittacula krameri*). The streams at the bottom of the valley had a flock of Large Crowned Willow Warbler (*Phylloscopus occipitalis*). 4 Crested Serpent Eagles (*Haematornis cheela*) circle it mostly in their flights and rarely go outside.

In forest Type B on the road from Watch Tower 4 to 5 Nilgai (*Boselaphus tragocamelus*) and Bison (*Bibos gaurus*) exist. The bison number about 4, but the nilgai appear isolated and could not be counted with any degree of accuracy. This area has more Black Partridges (*Francolinus francolinus*) than the other areas.

TYPE A: This type provides the richest bird life and the largest mixed hunting parties. The pure *B. serrata* patches have a party of Rufousbacked Shrike (*Lanius schach nipalensis*), Eastern Orphean Warbler (*Sylvia hortensis*), Grey Shrike (*Lanius excubitor*), Redvented Bulbul (*Pycnonotus cafer*), Magpie Robin (*Copsychus saularis*), Whitebrowed Fantail Flycatcher (*Rhipidura aureola*), Redwhiskered Bulbul (*Pycnonotus jocosus*), and the Large Crowned Willow Warbler (*Phylloscopus occipitalis*). Spotted Deer (*Axis axis*) and Nilgai (*Boselaphus tragocamelus*) are found in this type; as a matter of fact since the forest is more open the number of spotted deer is larger, and I place their numbers at about 20 in this area.

In Type A 1 hares (*Lepus ruficaudatus*) and pigs (*Sus cristatus*) occur in larger numbers than in the other type, otherwise it has no special ecological significance.

TYPE C: On the artificial lake behind the dam the only pair of Redwattled Lapwings (*Lobivanellus indicus*) and Common Sandpipers (*Actitis hypoleucos*) were seen. These roost also in the same area. The stream beds generally have a greater abundance of Wagtails (*Motacilla*) and Warblers (*Phylloscopus*).

The road leading from the Forest Rest House to the National Highway has forests falling in types A and B, but the structure of the fauna is rather unique. Along here the only specimens of Crimsonbreasted Barbet (*Megalaima haemacephala*), Stone Chat (*Saxicola caprata*), Verditer Flycatcher (*Muscicapa thalassina*), Blue

Rock Pigeon (*Columba livia*), Blackheaded Shrike (*Lanius schach tricolor*) were seen. A couple of leopards (*Panthera pardus*) were also observed in long grass along a stream bed. Leopards generally are scarce in the National Park.

8. RESULTS

MAMMALS. The mammal population has been estimated by multiplying the number found in the area sampled by 5; since the sampling unit was 1/5th of the total area of the Park. In other words the sampling intensity has been assumed to be 20%. Whilst no mathematical justification can be given for this assumption, yet it was the only basis on which the survey could be carried out. The results are given below:

Species	No. in sampling area	No. in Park	Remarks
1. Common Langur (*Semnopithecus entellus*)	not seen	not seen	Reported by staff to be present in large numbers near villages.
2. Tiger (*Felis tigris*) ..	2	10	Staff estimate the number at 15.
3. Leopard .. (*Panthera pardus*).	2	10	Staff estimate the number at 9.
4. Mongoose (*Herpestes* .. *edwardsii*)	4	20	—
5. Jackal .. (*Canis aureus*)	not seen	not seen	Reported by staff as entering the villages.
6. Fox (*Vulpes* .. *bengalensis*)	Frequent	Frequent	Numbers not estimated.
7. Wild Dog .. (*Cuon alpinus*)	not seen	not seen	Reported by staff as visiting sometimes.
8. Sloth Bear (*Melursus* .. *ursinus*)	6	30	Staff estimate the numbers at 25.
9. Palm Squirrel (*Funambulus* .. *pennanti*)	2	10	—
10. Common Hare (*Lepus* .. *ruficaudatus*)	very common	very common	—
11. Bison .. (*Bibos gaurus*)	4	20	Appears to be an over estimate. Probably there is only one herd of 4.

Species	No. in sampling area	No. in Park	Remarks
12. Nilgai (*Boselaphus tragocamelus*) ..	3	15	—
13. Sambar (*Rusa unicolor*) ..	6	30	—
14. Spotted Deer (*Axis axis*) ..	30	150	—
15. Muntjac (*Muntiacus muntjak*) ..	4	20	—
16. Wild Boar (*Sus cristatus*) ..	common	common	—

A remarkable feature was the complete absence of the Primates. Though the staff reported that the Langur was present in large numbers, not even one was seen by me either in the area sampled or outside. Probably the Lynx (*Caracal caracal*) was seen but as it disappeared very quickly and did not allow me to get close enough, I could not identify it with certainty. It has, however, been reported as present by Mr. N. N. Sen, Chief Conservator of Forests, Rajasthan, who saw a single specimen in December, 1957, vide *J. Bombay nat. Hist. Soc.* (1959) **56** (2): 317.

All the animals are extremely shy and even after five years of protection disappear on the slightest noise. Their fear of man has not been overcome to the smallest extent, and they are as shy and wary as in any forest area where animals are not specially protected. In this connection I received reports that poaching by privileged persons has not been completely stopped. Rather I learnt from a fairly reliable source that a local potentate shot within the Park 6 Spotted Deer in a single night, 2 of which were hinds.

BIRDS. The following birds were seen:

1. Night Heron, *Nycticorax nycticorax*—3. There was a heronry near Watch Tower 5.
2. Whitenecked Stork, *Ciconia episcopus*—1. Probably a straggler.
3. Common Sandpiper, *Actitis hypoleucos*—2. Winter visitor.
4. Redwattled Lapwing, *Lobivanellus indicus*—2.
5. Black Partridge, *Francolinus francolinus*—Frequent.

6. Red Junglefowl, *Gallus gallus*—Common, but very shy.
7. Peafowl, *Pavo cristatus*—1, but staff report it as frequent on the western fringes of the Park.
8. Ring Dove, *Streptopelia decaocto*—Very common.
9. Spotted Dove, *Streptopelia chinensis*—Infrequent.
10. Blue Rock Pigeon, *Columba livia*—4.
11. Crested Serpent Eagle, *Haematornis cheela*—4.
12. Dusky Horned Owl, *Bubo coromandus*—Common.
13. Mottled Wood Owl, *Strix ocellata*—1.
14. Common Indian Nightjar, *Caprimulgus asiaticus*—Common.
15. Whiterumped Spinetail, *Indicapus sylvaticus*—A flock of about 6.
16. Whitebreasted Kingfisher, *Halcyon smyrnensis*—Frequent.
17. Common Kingfisher, *Alcedo atthis*—Frequent.
18. Green Bee-eater, *Merops orientalis*—4.
19. Indian Roller, *Coracias benghalensis*—one pair.
20. Roseringed Parakeet, *Psittacula krameri*—Very common.
21. Large Indian Parakeet, *Psittacula eupatria*—Frequent.
22. Crimsonbreasted Barbet, *Megalaima haemacephala*—Common.
23. Green Barbet, *Megalaima zeylanica*—Frequent.
24. Goldenbacked Woodpecker, *Dinopium benghalense*—Common.
25. Pigmy Woodpecker, *Dendrocopos nanus*—Frequent.
26. Mahratta Woodpecker, *Dendrocopos mahrattensis*—Common.
27. Tickell's Flowerpecker, *Dicaeum erythrorhynchos*—Frequent.
28. Purple Sunbird, *Nectarinia asiatica*—Very common.
29. Eastern Grey Wagtail, *Motacilla caspica*—Frequent. Winter visitor.
30. Whitefaced Wagtail, *Motacilla alba leucopsis*—Frequent. Winter visitor.
31. Common Swallow, *Hirundo rustica*—A flock of about 9. Winter visitor.
32. Common Myna, *Sturnus tristis*—One pair, probably stragglers.
33. Golden Oriole, *Oriolus oriolus* (*kundoo*)—Frequent.
34. Jungle Wren Warbler, *Prinia sylvatica*—Common.
35. Large Crowned Willow Warbler, *Phylloscopus occipitalis*—Frequent. Winter visitor.
36. Green Willow Warbler, *Phylloscopus trochiloides*—Frequent. Winter visitor.
37. Eastern Orphean Warbler, *Sylvia hortensis*—Rare. Winter visitor.

38. Tailor Bird, *Orthotomus sutorius*—Common.
39. Whitebellied Drongo, *Dicrurus caerulescens*—Very common.
40. Black Drongo, *Dicrurus macrocercus*—Rare.
41. Small Minivet, *Pericrocotus cinnamomeus*—Common.
42. Blackbacked Pied Shrike, *Hemipus picatus*—Frequent.
43. Rufousbacked Shrike, *Lanius schach nipalensis*—Frequent.
44. Blackheaded Shrike, *Lanius schach tricolor*—Frequent.
45. Grey Shrike, *Lanius excubitor*—Frequent.
46. Whitebrowed Fantail Flycatcher, *Rhipidura aureola*—Common.
47. Verditer Flycatcher, *Muscicapa thalassina*—1. Winter visitor.
48. Tickell's Blue Flycatcher, *Muscicapa tickelliae*—Common.
49. Redbreasted Flycatcher, *Muscicapa parva*—Common. Winter visitor.
50. Magpie Robin, *Copsychus saularis*—One pair.
51. Indian Robin, *Saxicoloides fulicata*—Common.
52. Stone Chat, *Saxicola caprata*—Frequent.
53. Redwhiskered Bulbul, *Pycnonotus jocosus*—-Rare.
54. Redvented Bulbul, *Pycnonotus cafer*—Very common.
55. Goldfronted Chloropsis, *Chloropsis aurifrons*—Common.
56. Common Iora, *Aegithina tiphia*—Common.
57. Yelloweyed Babbler, *Chrysomma sinensis*—Common.
58. Jungle Babbler, *Turdoides somervillei*—Very common.
59. Treepie, *Dendrocitta vagabunda*—Very common.
60. Jungle Crow, *Corvus macrorhynchos*—Common.

The following mixed hunting party invariably gathered in a small area between the Forest Rest House and the Tourist Lodge, both in the morning and the evening. It almost seemed as if this party assembled in the morning just before dispersing and again in the evening just before roosting.

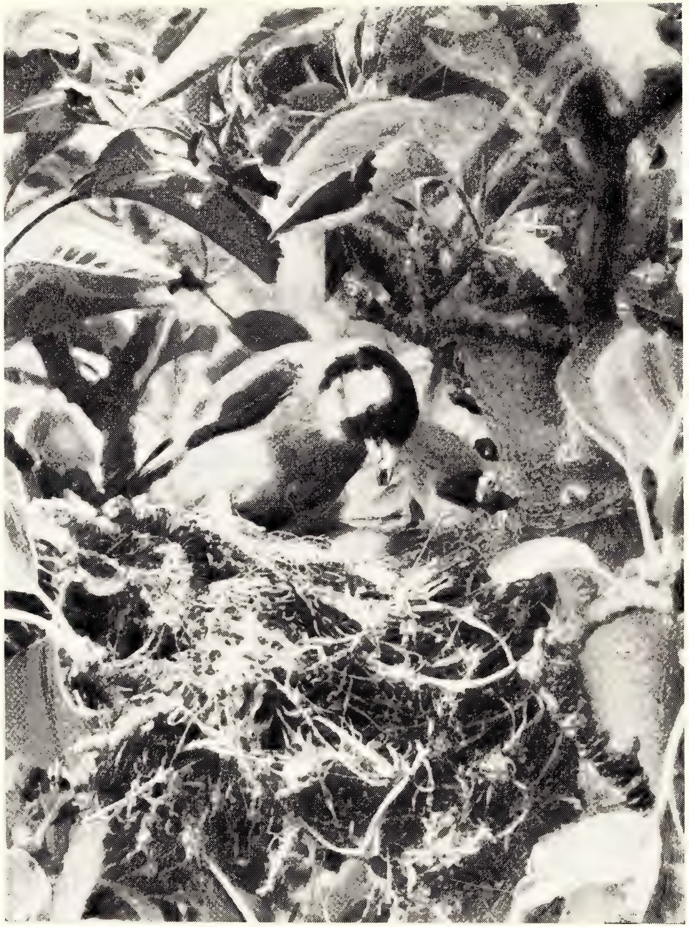
Treepies, Redvented Bulbuls, Jungle Babblers, Redbreasted Flycatchers, Crimsonbreasted Barbets, Ioras, Whitefaced Wagtails, Eastern Grey Wagtails, Common and Whitebreasted Kingfishers, Jungle Crows, Common Mynas, Tailor Birds, Goldfronted Chloropses, Goldenbacked and Mahratta Woodpeckers, and Indian Robins. The entire party had a strength of from 70 to 80 birds.

The above list shows that bird life is poorly represented. As against only 60 species as many as 108 were recorded in the Kodarma Sanctuary lying only some 35 miles to the north. That too in a survey that was very sketchy compared to the intensity of the present one. The absence of game birds of all kinds, particularly Grey Partridge, Spurfowl, and Quail, is noticeable. I saw only one peafowl which is surprising. Even common birds like egrets, kites, hornbills, and practically all the birds of prey are missing. Except for a pair of Common Mynas, which too showed signs of having strayed in, no members of the genus *Sturnus* were recorded. Even a very common bird like the Pied Myna was absent.

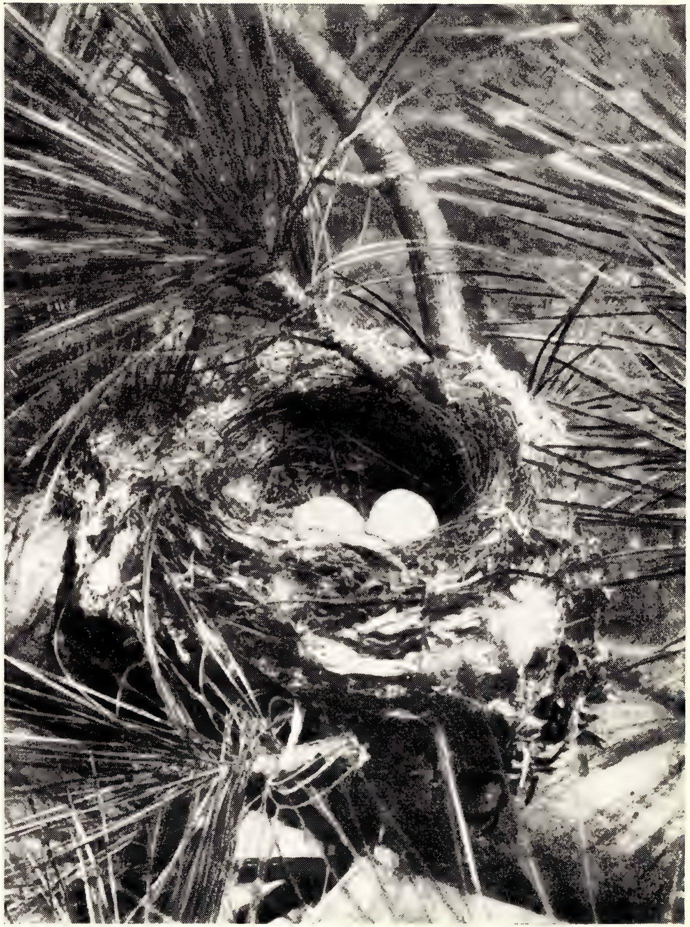
The place of the Black Drongo has been taken here by the Whitebellied Drongo. I saw only 2 pairs of Black Drongos, whereas the Whitebellied ones were very plentiful. Again the Spotted Dove appears to have been supplanted by the Ring Dove. In spite of the area being very well watered waders were absent.

9. Acknowledgements

This survey was made possible by a handsome contribution from the Bombay Natural History Society out of funds made available by the Rockefeller Foundation. In addition I thank Mr. B. K. Sahay, Conservator of Forest, Northern Circle, Bihar, and his staff for very great co-operation and help in the carrying out of this investigation and for making my stay in the National Park a very pleasant experience. Mr. Sami Ahmad, Forest Officer, very kindly identified the plants and helped me with the ecology.



Female European Goldfinch regurgitating seeds



Nest and eggs of Himalayan Goldfinch

Photos : R. S. P. Bates

The Nesting Habits of the Goldfinch *Carduelis carduelis* (Linn.) & *C. caniceps* Vigors

BY

R. S. P. BATES

(*With a plate*)

The Goldfinch, a truly delightful bird in every way, in dress, in voice, and in habits, has a wide range over the greater part of Europe and a good slice of Asia, inclusive of the frontier hills of West Pakistan and thence in India along the western Himalayas to about Kumaon. The genus is divided into two species, the typical *carduelis* and the eastern *caniceps*, both subdivided into races of which the Himalayan bird is the most easterly form of all.

On coming into close contact with Goldfinches here in England after meeting their counterparts in Asia I find myself wondering what lies behind this separation into two different species. One realises that a vast range with its consequential differences in climatic and other conditions is bound to result in the production of numbers of somewhat differing forms, so that the Himalayan Goldfinch at one extreme is almost bound to possess some striking difference from the English bird, in this case the lack of any black about the face. Nevertheless I find the ways of both species so strikingly similar, inclusive of the choice of nesting site, the architecture of the nest and the material, manner of its construction, incubation and feeding, movements after nesting, the delightful call notes, joyous song, and so on, that I find it difficult to believe that there really are two true species. Indeed would not, I wonder, individuals picked up at random from anywhere along this long line, whether belonging to *carduelis* or *caniceps*, be perfectly happy to breed together? In short, could not the whole lot belong in reality to but one species?[1] This is of course probably nothing more than wishful thinking on my part and I would not really presume to contradict the taxonomists, who with their access to large collections and far more literature than I am ever likely to see, do not have to rely on a few impressions and consequently have probably got the strongest of reasons for carving up our palaearctic goldfinches. I could, I suppose, even be wrong in crediting the different forms with identical ways, and therein lies my whole object in putting this article on paper: someone may like to pull my ideas to pieces and show up the error of my ways. My contacts with the Indian bird on the north-west frontier of West Pakistan and in Kashmir, though pretty frequent, admittedly have always been of short duration, and I never had the chance of following a pair of goldfinches right through their nesting cycle as I have just done this summer in my garden in Surrey.

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[1] In A SYNOPSIS OF BIRDS OF INDIA AND PAKISTAN by Prof. S. Dillon Ripley (in press) both the British and the Himalayan Goldfinch are recognized as races of *Carduelis carduelis*. EDS.

In the Vale of Kashmir the Himalayan Goldfinch is common enough the year through, and in early spring plenty of nests are to be found in a variety of situations. I have come upon them in willows lining water channels, in fruit trees in the orchards, and of course amongst the smaller branches of fir and pine trees, but I believe the pine wood on the Takht-i-Suleiman, mentioned by almost every ornithologist who has written about them, first dwindled and then disappeared altogether some years ago. In the summer numbers of goldfinches move up the side valleys to quite high elevations, many of the young then produced probably being second broods, and it was one of these higher elevation pairs which produced the most striking nest I have ever seen. I found it on June 22nd at an elevation of about 10,400 ft. between Bal Tal and the Zoji La Pass into Ladakh. The site was typical, being about 3 ft. out and 15 ft. from the ground on a horizontal branch of a small pine tree, and the general construction was quite normal, a beautifully soft affair containing the usual thick inner wad of felted vegetable down finished off with a somewhat scant inner lining of hair. The outer materials were perhaps a little unconventional for, to quote from my remarks about this nest in my diary: 'Two-thirds of it were exclusively of Edelweiss and forget-me-nots quite fresh-flowering stems which I suppose the bird had cut itself? Then came a thick layer of dandelion down. Finally it was lined with horse-hair but inside on the bottom was a further limited quantity of dandelion down . . . On the way back from the Zoji La saw three pairs of goldfinches on the ground near the same place. It does seem, by the way, that where there is one pair nesting there may well be a number spread over a very limited area.' Later I wrote: 'The eggs have a transparent appearance unmarked and white when blown, but they are by no means as fragile as they look.' I came upon one other unmarked clutch in a nest near Nagmarg above the Wular Lake.

Shortly after returning to England in 1946 I had a couple of sessions at a goldfinch's nest in a hawthorn tree and watched, but failed to photograph, the transference of predigested food from the male to the sitting female; and noted too how a beautiful nest, neat, soft and cosy-looking, became within a week of the young being hatched, an offensive ring of droppings through lack of attempt at nest sanitation. Nests noted since then were either in situations unsuitable to deal with, or came to an untimely end thanks to the appalling increase in predators during and immediately following the war; magpies, jays, and Grey Squirrels in the main, the latter more fittingly called tree-rats, real horrors and not in the least lovable as are India's confiding little rascals, the Striped Palm Squirrels.

At last in the first week of July this year I found I had a goldfinch's nest only 9 ft. from the ground, hidden in a cup of small shoots near the top of an apple tree in our own garden. We also had two others, one of them hopelessly placed amongst the outer branches of a tall Sweet Chestnut tree and the second in a cedar which I did not spot until too late and which was probably the earlier nest of the pair I was now to deal with. Although I had of course heard and seen the goldfinches moving about the orchard—the bright plumage and mellow call-notes incessantly indulged in saw to that—I had not realized that this second nest was already in being. It contained, in fact, 2 eggs and incubation seemed already to have commenced. Basically the nest was constructed just like others I have come across, whether in the Himalayas or in Britain. The outer parts contained one or two thin twigs, but in general it seemed to be made of dry grass and soft weed stems, the inner felted cup being about one-third of an inch thick made of some vegetable down khaki in colour. This was rounded off with a final scanty lining of white hairs belonging to one of our Cocker spaniels. An interesting point was that amongst them was not one single hair from the Golden Cocker's coat which would, in fact, have matched the felt core instead of contrasting with it.

On the 7th I found a third egg had been deposited, but it is in no way unusual for goldfinches, British goldfinches anyway, to begin incubation before the deposition of the full clutch, which in this case proved to be one of three eggs only.

The next few days were spent in getting the sitting bird thoroughly used to traffic and other noises so that my wife and I could eventually talk and move about directly below the nest without causing her the least embarrassment. When I erected a pylon hide on a triangular platform made by resting a couple of planks on a rung of a vertical aluminium ladder with their other ends through the garage windows she did not bother to leave the nest until I got on to the platform to put up the hiding tent within 4 ft. of her. By the way the Bal Tal bird was just as tame and returned to within 6 inches of the nest while my head was still almost level with her.

Early on the morning of July 18th I found that two of the eggs hatched, but it was some time in the afternoon of the 19th before the third chick arrived. I replaced the dummy lens with the reflex equipped with an 8-inch Cooke lens, and getting inside the hide let off the focal plane shutter a few times to test the effect on the sitting bird. She jumped once or twice at the snap of the falling blind, but soon took no notice of it whatsoever. Unfortunately from beginning to end the male reacted unfavourably every time the blind dropped, and usually made off like a scalded cat. He always did leave with unexpected suddenness anyway, and never gave me a chance of two exposures during any one visit.

I already have good photographs of an incubating female, so wished to concentrate on the passing of food by the visiting male. The female seldom leaves the nest except, I suspect, for the purpose of drinking, being relieved of any such necessity by being fed by the male by regurgitation. You see goldfinches are typical finches in that they have strong, though in their case rather long, conical bills specially adapted for crushing seeds. This does not mean that they eat nothing else, but seeds do form by far the greater proportion of their diet. Numbers of finches however feed their youngsters, like so many small birds do, on insects, but goldfinches and some others of the family have got over the dangers of giving their chicks tummyache through feeding hard seed to them by predigesting this type of food and storing it up in their own crops to feed to the young in bulk. This means of course that the nest need only be visited at infrequent intervals, a practice which has its disadvantages as will in due course be seen.

At 11 o'clock the male appeared on the rim of the nest and was greeted by the sitting bird at once soliciting food with head thrown back and bill well opened. He promptly sank his own bill well into her throat, but I could at times see a stream of matter of the consistency and colour of thick cream flowing into her gape. The flow lasted an appreciable time with a slight raising and lowering of his head which was why I could occasionally see the flow. The female did not immediately pass on this gruel to the young ones but covered them for another seven minutes. She then stood up and so far as

I could tell fed her two offspring. Unfortunately the chicks were so tiny that their heads did not come above the rim of the nest.

By the 20th it had become evident that the male's visits were at intervals of not less than half an hour, and that the female usually passed on the food within from 5 to 10 minutes of a visit. On one occasion, however, more than 40 minutes elapsed between visits. This time the female fed the young twice, that is 5 minutes after his visit and again half an hour later. It seems therefore that she can retain the food in her crop at the right consistency for some time. Once the female seemed to regurgitate a small seed which I could see her holding in the tip of her bill before feeding it to one of the chicks. On another occasion, but after the male had commenced to supply the chicks direct, he produced what I am almost certain was a spider still with its legs intact.

The change over to direct feeding of the young by the male was most interesting and I was indeed lucky to be in the hide to witness it. On the 21st before entering the hide I had snipped off one or two leaves above the nest which were throwing awkward shadows. In so doing I inadvertently dropped a tiny bit of debris into the nest cup. The female returned almost as soon as I was comfortably settled in and brooded the young for quarter of an hour. Then she stood up and for 5 minutes or so cleaned up the nest and attended to the young. The rim of the nest was still absolutely free from excreta. She appeared indeed at this stage still to be swallowing the faecal sacs. The chicks in any case were too small to be able to eject excreta on to or over the rim. So here is a passing thought: how is the mother bird at one moment able to swallow faeces yet very soon afterwards bring up food for the young?

I could see her nibbling something in the bottom of the nest then she picked up my bit of debris and flew away with it. Shortly afterwards the male flew in. Finding his mate absent he just stood on the edge of the nest looking rather non-plussed. Then the three chicks showed their open gapes dithering in the sunlight below him. The spell was broken; he soon started to feed them but, his method at once changed. No longer was it a rather deliberate process of continual regurgitation. He fed them in strict rotation with quick dabs of the bill into each open gape, repeating the round two or three times. Halfway through this the female appeared on the back of the nest and at once solicited food for herself. He merely included her in the rotational round, using the same dabbing motion for her as for the chicks. From then on both parents started to feed the growing family though on one occasion the male arrived when his wife was brooding the chicks who now took up sufficient room in the cup to necessitate her sitting rather perched up in the air. He fed her in the old deliberate manner stretching well up to enable him to insert his bill into her up-turned gape though there was a certain amount of up and down movement involved. Unfortunately I waited a little too long for a favourable moment to press the release and lost the opportunity altogether. As the young grew, I expected the parents' visits to increase in frequency but the minimum interval of half an hour was maintained throughout. The fact that both parents were now employed in food collection provided, I suppose, the necessary increase in supply. There appeared to be no co-ordination between the parents as to the spacing of their visits. At times both would arrive almost together with much melodious calling to one another; sometimes the intervals would be more or less evenly spaced. In other words, the times of arrival were quite fortuitous. Both birds had their fixed lines of approach, the female always directly on to the back of the nest while the male flew in from another apple tree to my right but alighted on the left front side of the nest. I wonder if this had anything to do with the youngsters' choice in the location of their latrine?

I have already said that the female kept the nest clean so long as she was continuously brooding the callow young. She continued to do so for two or three days after she had joined the male in food collection. From the 25th, however, I began to notice that droppings were commencing to soil that quarter of the rim to my right front and no attempt was made by either parent to remove them—the male never had taken an interest in nest sanitation anyway. What happens appears to be this: anything falling inside the cup is removed by the female, but as soon as the young are big and strong enough to deposit the faeces beyond the inner cup itself, no matter how near to it, they are ignored. By the 29th the young filled the whole cup and when one wished to defecate there would be a general upheaval, the chick concerned pushing its brethren around until it could raise its tail end roughly in the right direction, that is towards my right front. The droppings were ejected with a certain amount of force but never with sufficient vim to clear the nest altogether with the result that by the time the young flew there was a sticky congealed mass bulging out from the side of the nest in the most favoured spot by a good inch, and the whole of that sector of the nest facing me had become soiled in some measure.

On the 31st the male suddenly changed his line of approach—possibly because his pet perch had become dirty and slippery—and started to land on the extreme right front of the nest. This was a nuisance so far as I was concerned as part of his body was shielded from the lens by one or two leaves on an upward-growing spur starting just below the nest. The young were now practically ready to leave, the two first-hatched frequently indulging in vigorous wing-whirring exercises. I felt I could get better photographs of this and of the male on his new perch by removing the masking spur, so when my wife arrived to call me in for a meal I asked for her secateurs. I thought that if I cut off this twig at its base below the nest the young would not be able to see me and so would not take alarm. All went well and the offending thing was nearly severed when the secateurs went through the last bit of wood with an unfortunate click. To my horror the whole nestful 'exploded', the three young taking off in different directions but fortunately all landing safely in a plum tree and some bushes behind a herbaceous border. Moral: do any gardening likely to be necessary before the young become fear-conscious.

Fortunately there was still a chance of recording the fledglings' plumage. In front of the house there is a lily-pond with a stone bird-bath close beside it. I had noticed that another goldfinch family consisting of the adults with one surviving juvenile visited this bath very frequently so I at once moved the hide, placing it on the narrow strip of grass between the pond and the wall and 7 ft. from the bath. Therein I made a grave mistake; for a solid week nothing came near that bath, not even the cheeky sparrows. Thinking things over I concluded that the hide must be blocking the birds' usual lines of approach and departure but it was not easy to put the hide elsewhere. I could not place it to the north of the bath for the light would have been all wrong. The only way out of the dilemma was to put it right up against the wall so that most of the tent was on top of the wall with its front panel just far enough out to allow me to lean back against the wall with the toes of my shoes just peeping out, one leg of the camera tripod leading under my left armpit on to the grass on the top of the wall into which it was firmly pegged, the other two legs sticking out on either side of the front panel just by my feet. My position in the hide was by no means uncomfortable—I had of course to stand all the time, but the wall sloped back slightly so I could rest against it.

Birds are queer things! Although the hide was now closer to the bath every bird in the garden appeared to be satisfied with the change. The weather was hot and brilliant so bathing and drinking became the order of the day with practically all species. If I had been able to stay in the hide all day and every day my list of captures would undoubtedly have been of considerable length. Alas, I had other jobs to attend to at times, and food to get down me. My annoyance can be imagined when in the middle of lunch the bath was visited first by a pair of Yellow Buntings and immediately afterwards by a nightingale with one of its fledglings. But I must not wander at the moment from my main theme. Unfortunately the abortive week turned the scales against me. A change was coming over the behaviour of the finches in general and the goldfinches in particular. For one thing the harvest had begun and this was probably a contributory factor to the change in the behaviour of many species as well as the fact that no longer were so many of them tied to one small area through having nests to think about. Of course I often heard the goldfinches and greenfinches in the garden, but just as often they went further afield and also joined up into flocks with other family parties. No longer did the goldfinch parents with one juvenile appear so regularly and indeed their visits soon petered out altogether. To cut a long story short I never did get that juvenile plumage photograph.

On one occasion I was in the tent the whole morning during which I photographed Willow Warbler, Blue Tit, Robin, and cock House Sparrow bathing, and in addition a whole family of greenfinches the members of which came a number of times, once with an adult goldfinch, but at last I had to pack up. Pulling a polythene bag over the camera I undid the press-studs down one side of the tent and prepared to leave. To my utter confusion just as my posterior was sticking out into the open air like the Rock of Gibraltar emerging from the sea, with much twittering my whole goldfinch family descended on to the rim of the bird bath. Needless to say I made a frenzied effort to get back to cope with the situation but they left as suddenly and joyfully as they had arrived just as I finished focussing and picked up the shutter release! And so my last opportunity ended in failure.

I learnt quite a lot of things from the bird bath attempts, one being, as of course one might expect, that seed-eaters in general and goldfinches and greenfinches in particular, and I might also add crossbills, drink very frequently. Blackbirds drank hardly at all, the moisture they required coming mainly from our fallen apples, and only once did I see a Blackbird take a bath—they prefer to sun-bathe. Song Thrushes too drink infrequently, probably getting their moisture from snails and other soft food, but they bathe rather more frequently. The cheeky sparrows in spite of their hoydenish ways seemed to love the water more than any other bird, both bathing and drinking at very frequent intervals.

And now one last tip for bird-photographers. For more than four weeks I left the camera, at times with a plate in position, in the hide in all weathers—indeed sometimes the hide was flooded out. Its sole protection night and day when I was absent was a polythene bag pulled right over the lens, camera, and tilting-top, held together underneath by a tight rubber band. I had no trouble from condensation either on the focussing screen or on the lens and found I could be quite ready for action within a couple of minutes of getting into the hide, only having to check up on the exposure, stop, and focussing, to ensure that all was in order.

Aspects of Vegetation of Church Island off Tuticorin Port in South India

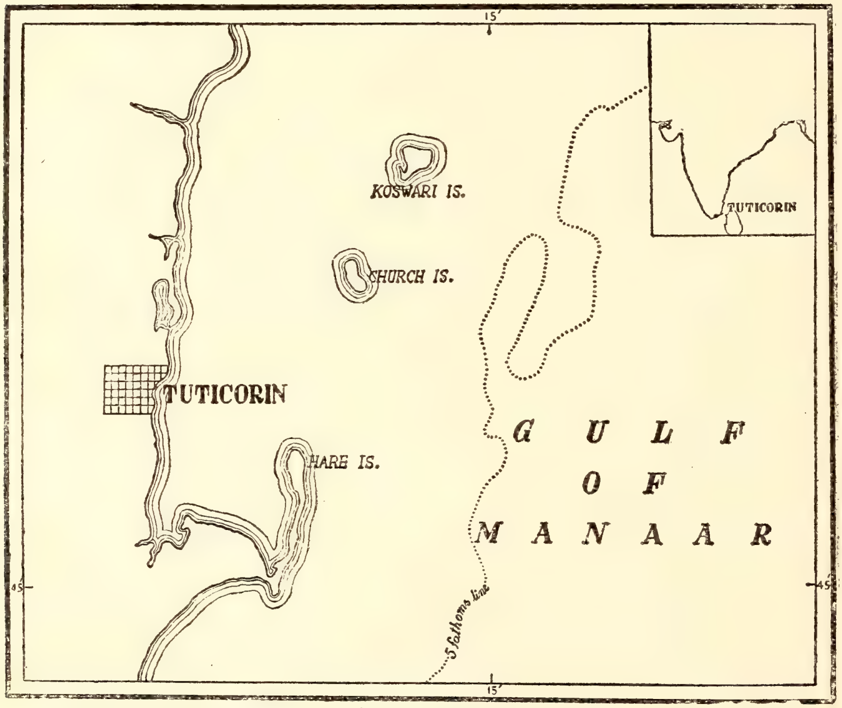
BY

K. S. SRINIVASAN

Curator, Industrial Section, Indian Museum, Calcutta

(*With one text map and three plates*)

Tuticorin (8° 48′ N. & 78° 11′ E.) is an important sea-port in Tinnevelly District (Madras) in south India. Off Tuticorin coast and east of it in the Gulf of Manaar there are a few islands, the more popular among them being Hare Island, Church Island, and Koswari Island (text map). Having had lately an opportunity of examining the floristic features of Church Island in December 1957 during a deep-sea marine algal collection trip to the Gulf of Manaar, I record here


15'
KOSWARI IS.
CHURCH IS.
TUTICORIN
HARE IS.
TUTICORIN
G U L F
O F
M A N A A R
5 fathoms line
45
45
15'

Map showing the situation of Church Island, off Tuticorin coast, S. India the results of my observations on the flora of the island, as practically no previous record is available on the same.

The island, the flora of which is described here, would appear to be geologically a portion of the stretches of coral islands in the Gulf of Manaar. Among the group of islands in the area, Hare Island is perhaps the largest. It is about 4.83 km. away from Tuticorin port and has about 58.85 hectares of land area. There is a lighthouse at the northern extremity. This island is connected with the mainland through a marshy tract, which during high tide is submerged at least in part. At other times communication is possible along this tract, and the island can be reached from Tuticorin by the land route which is about 11.26 km. long. The island is practically uninhabited except for the lighthouse personnel.

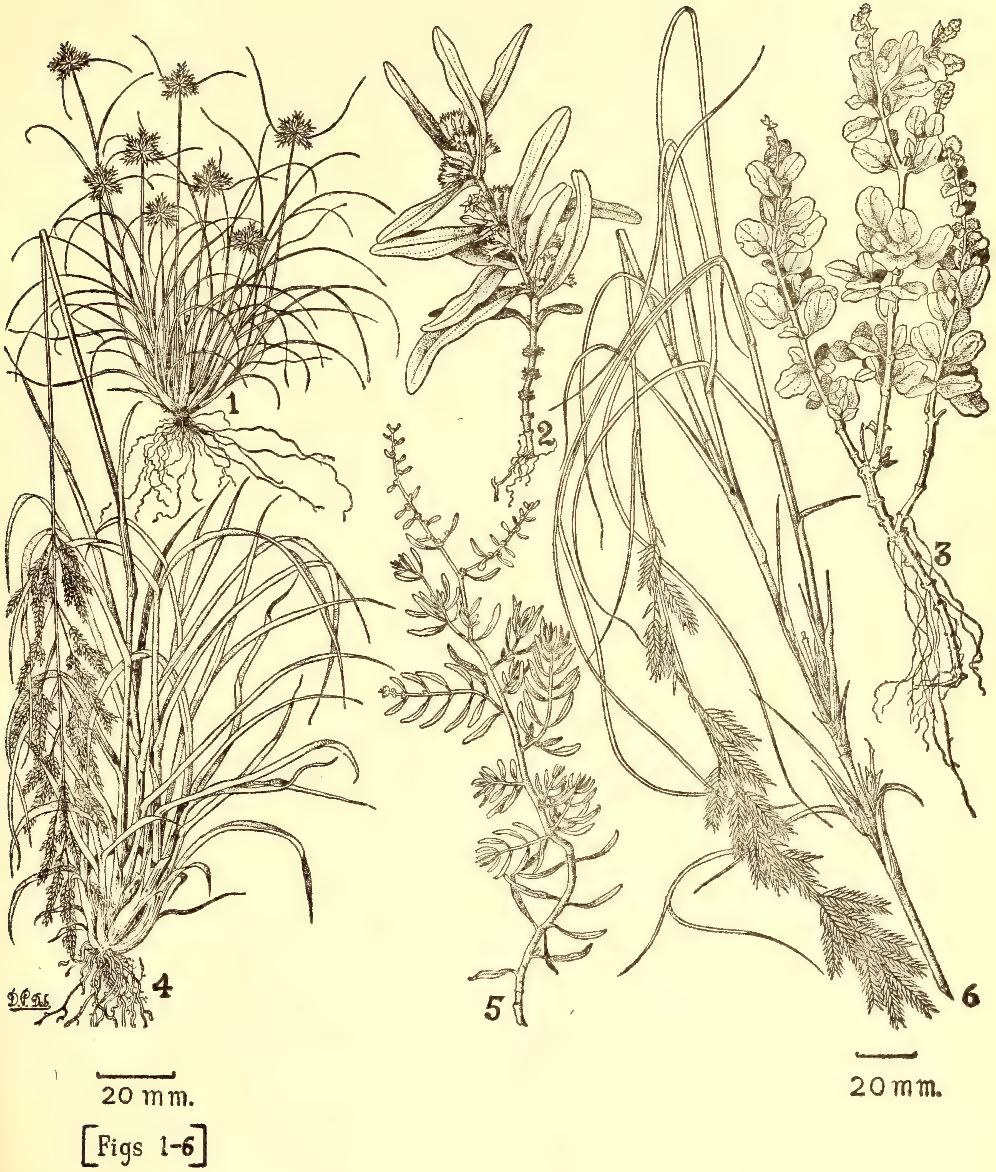
Church Island lies north of Hare Island and about 6.44 km. from the Tuticorin coast. When compared with Hare Island, it is much smaller and deep ocean channels separate it from the mainland and from the other islands. The island is uninhabited except for occasional visits of fishermen, fuel-gatherers, and coral stone cutters, who come to this and other neighbouring islands.

Church Island is practically flat and is only a few feet above mean sea-level with perceptibly no major undulations of sand dunes. The entire area of the island is practically covered with vegetation, though of restricted types. As a result, the whole island appears green throughout. Strangely enough, there are no trees of any appreciable size on this island. The vegetation is, thus, mainly characterised by low scrub or groups of shrubs and herbs, and small tussocks of grasses and sedges.

General Aspect of Vegetation

At the foreshore and well above the high-tide mark, *Sesuvium portulacastrum* Linn. forms extensive patches of creeping succulents with deep reddish colour in stems and older leaves. In places this species forms a more or less pure community. In other areas, *Suaeda fruticosa* Forsk. was met with along with *Sesuvium*, in sandy places as low bushes together with *Suaeda monoica* Forsk. A little to the interior and behind the *Sesuvium-Suaeda* belt, *Cyperus pachyrrhizus* Nees appears as a tall plant with large flower heads. Grasses and sedges were noted as most frequent from the foreshore to the very centre of the island. *Pycreus odoratus* Urb. was not uncommon just behind the belt of *Cyperus pachyrrhizus* Nees. In more or less open situations and on substrate which is composed of broken shells, dead corals, and coarse-grained sand, *Sporobolus tremulus* Kunth was noticed as wiry prostrate or spreading plants with erect panicles. Nearer shore, on small mounds, *Sporobolus indicus* R. Br. occupied large areas. Where the sand is more even and shells and dead corals not in such abundance as to characterise the area, *Bulbostylis barbata* Kunth with its needle-like leaves and tufted habit was most characteristic. This species was also noticed in various other situations and all over the island. *Spinifex littoreus* (Burm. f.) Merr. extends from the foreshore to the interior of the island, but occurs only here and there as a minor formation. Likewise, *Ipomoea pes-caprae* (Linn.) Sweet is seen in many places but nowhere does it cover large areas to form pure or major formations. In the midst of *Spinifex littoreus* (Burm. f.) Merr. and *Ipomoea pes-caprae* (Linn.) Sweet, *Launaea sarmentosa* (Willd.) Alston (=*Launaea pinnatifida* Cass.) was fairly common. In places, some distance from the foreshore and in association with *Ipomoea pes-caprae* (Linn.) Sweet, *Scaevola plumieri* Vahl. forms low bushes. Here and there in this belt, *Dichanthium annulatum* (Forsk.) Stapf was noticed as a tall and stiff grass together with *Cyperus arenarius* Retz. The latter extends also to the foreshore, where it occurs in larger numbers. At other situations, a little into the interior of the island but not far from the coast, *Halopyrum mucronatum* Stapf was observed growing more or less prostrate with its somewhat rigid and stiff flowering axis erect. In somewhat protected areas *Scirpus affinis* Roth. was noticed on shingly ground. *Sporobolus marginatus* Hochst. ex A. Rich. (=*Sporobolus arabicus* Boiss.) was also common here and there in many areas. On sandy mounds and uneven undulations, not far from the coast, *Atriplex stocksii* Boiss. was found forming more or less open communities. In certain restricted places *Arthrocnemum indicum* Moq. was also growing on sandy tracts and mounds.

More to the interior and towards the central portion of the island the vegetation changes somewhat to low scrub and bushes, with herbaceous species intermixed. Towards the outer limits of this belt, on shingly ground with hard shells and dead corals, *Enicostemma verticillatum* (Linn.) Engl. (=*Enicostemma littorale* Bl.) is met with. *Salvadora persica* Linn. forms low and thin thickets here and there. *Oldenlandia umbellata* Linn. is another species found in many places in these parts of the island where the soil is firm and hard. The middle or central portion of the island was, to a very large extent, covered by *Indigofera oblongifolia* Forsk., forming a more or less pure stand or community in the island. The plants were stiff and low bushes so close together as to form thickets;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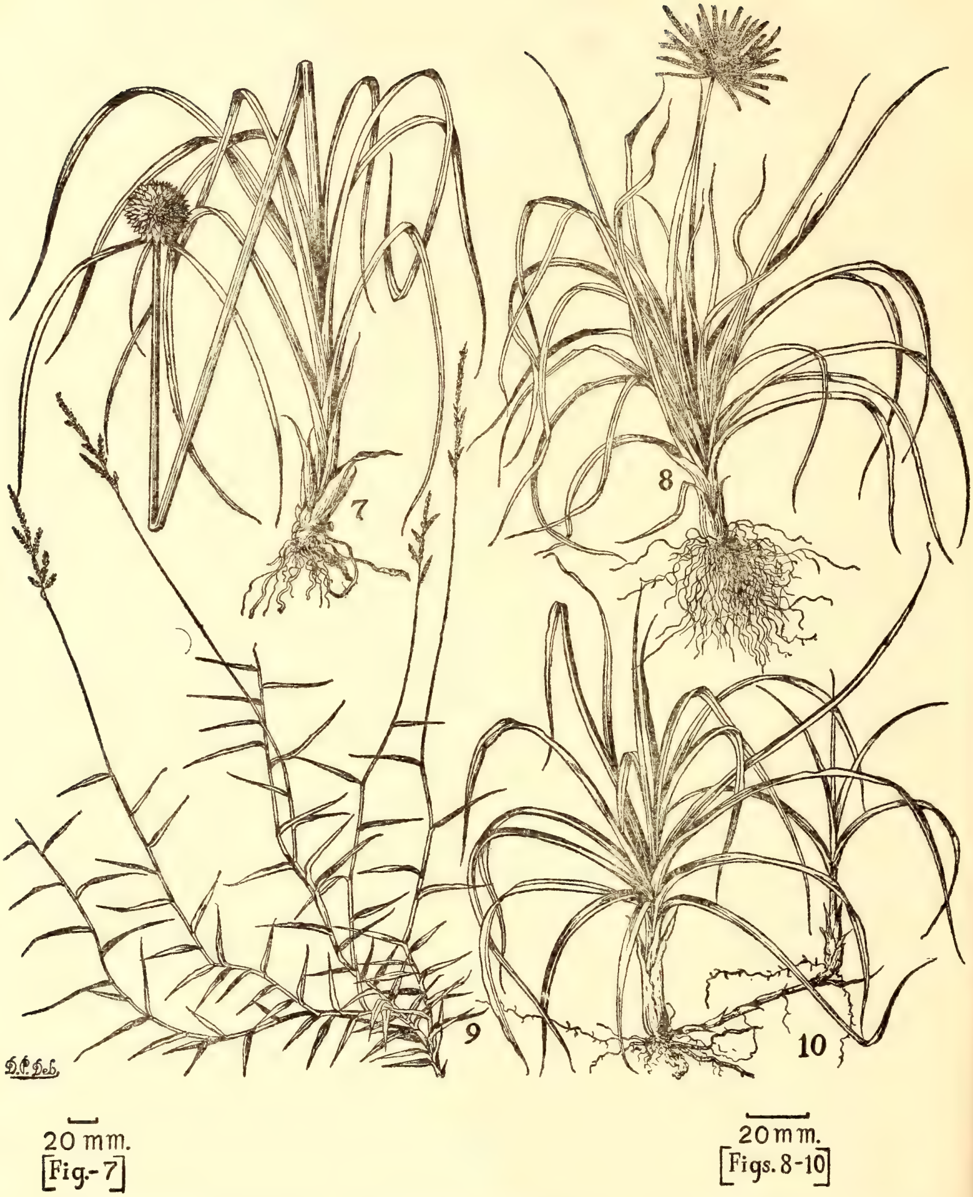
[Figs 1-6]

1. *Bulbostylis barbata* Kunth ; 2. *Enicostemma verticillatum* (Linn.) Engl. ; 3. *Atriplex stocksii* Boiss. ; 4. *Sporobolus indicus* R. Br. ; 5. *Suaeda fruticosa* Forsk. ; 6. *Halopyrum mucronatum* Stapf.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[Figs. 8-10]

7. *Cyperus pachyrrhizus* Nees. ; 8. *Pycreus odoratus* Urb. ; 9. *Sporobolus tremulus* Kunth ; 10. *Scirpus affinis* Roth.

under these *Bulbostylis barbata* Kunth was common. *Indigofera viscosa* Lam. was also noticed with *I. oblongifolia* Forsk. Here and there small *Acacia* plants were noticed. In shady situations seedlings of *Euphorbia* sp., *Acacia* sp., *Phaseolus trilobus* Ait. were also noted. Right in the centre of the island, and at the *Indigofera oblongifolia* Forsk. belt, there were two or three open patches of ground wherein *Aloe barbadensis* Mill. grew in numbers in almost pure formations; most plants were flowering profusely, their flowering tops with several scarlet flowers standing high above the general level of the vegetation of the island. They could easily be detected even from a distance.

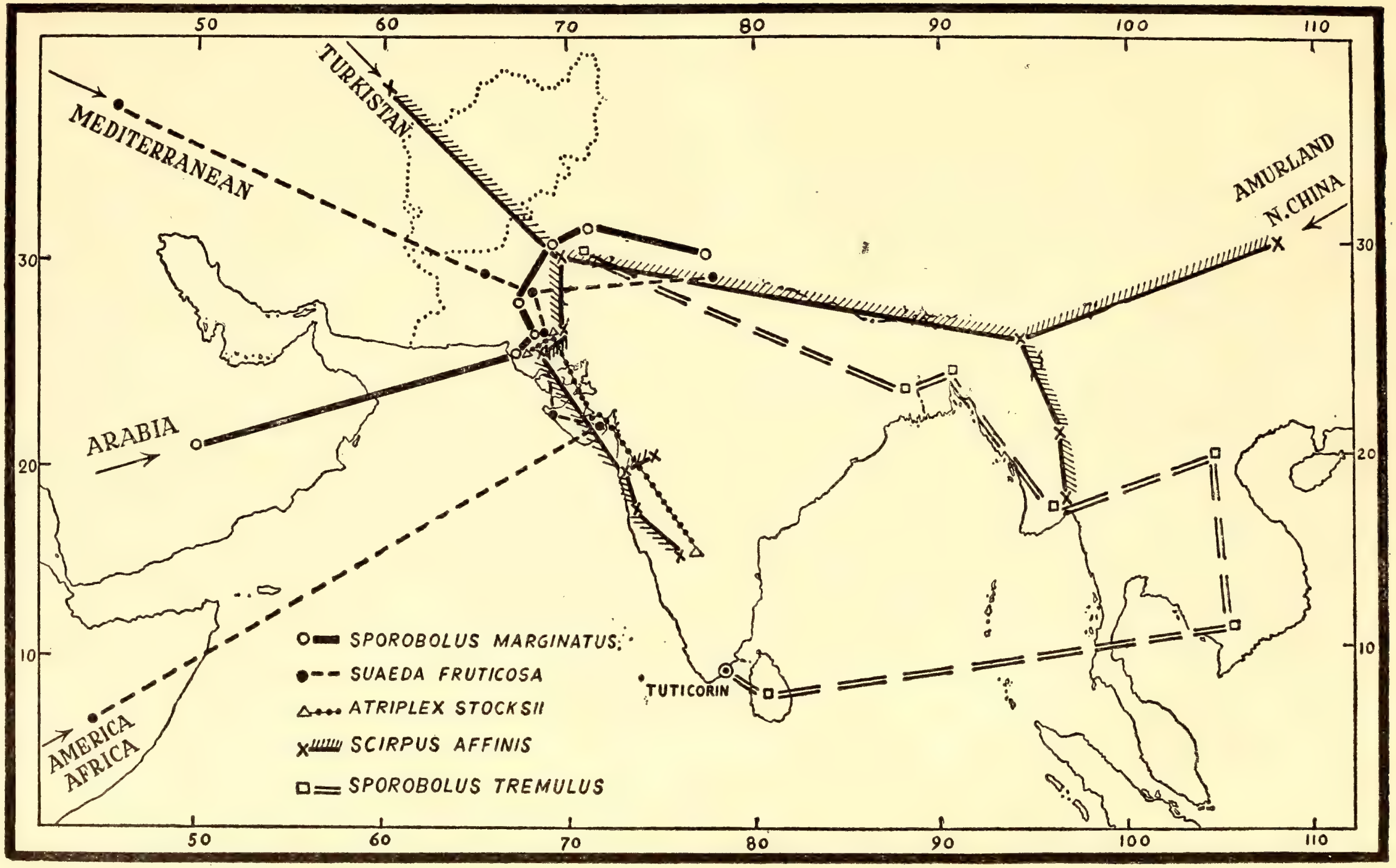
Special Features of the Vegetation

Absence of trees is characteristic of the island. The vegetation in the island is of a very open type, owing evidently to human interference. Although Church Island is very near to Hare Island, which again is not far off from the mainland, many of the species of Hare Island have apparently not succeeded in establishing themselves in Church Island so far. Thus, for example, *Thespesia populnea* Corr., *Acacia planifrons* W. & A., *Zizyphus jujuba* Lamk., *Jatropha glandulifera* Roxb., *Gloriosa superba* Linn., *Arthrocnemum fruticosum* var. *glaucum* Moq., *Cyperus aristatus* Rottl., *Chloris virgata* Sw., *Solanum xanthocarpum* Sch. & Wendl. are conspicuously absent from Church Island. Similarly *Cassia auriculata* Linn. and *Cissus quadrangularis* Linn., which were found growing over very extensive areas in Hare Island, were not seen in Church Island. Likewise Mangrove species have not set in in this island, obviously because the situations favourable for mangrove vegetation are not yet present in the island. It is interesting to note also that such conspicuous species as *Pandanus* and *Borassus*, which are present in other islands in the Gulf of Manaar, are not seen in Church Island.

Among the species now recorded from Church Island *Sporobolus marginatus* Hochst. ex A. Rich. (=*Sporobolus arabicus* Boiss.) *Scirpus affinis* Roth., *Atriplex stocksii* Boiss., and *Suaeda fruticosa* Forsk. would seem not to have been reported so far from the east coast of India, although their occurrence in the Punjab, Sind, and western Peninsula is recorded by Hooker and Cooke in the FLORA OF BRITISH INDIA and THE FLORA OF THE BOMBAY PRESIDENCY respectively. The occurrence of the species in Church Island is, thus, of considerable distributional interest.

Similarly, though species like *Sporobolus tremulus* Kunth, *Pycreus odoratus* Urb., *Dichanthium annulatum* (Forsk.) Stapf, are reported by Gamble from the Madras Presidency and the eastern peninsula of India, they are not reported by Cooke or Hooker in their respective floras, which would seem to suggest a restricted distribution in the eastern parts of south India.

From the accompanying map (Plate III) which indicates the general distribution pattern of the species referred to above within India, the following points would emerge. Among the species with westerly distribution in India, *Sporobolus marginatus* Hochst. ex A. Rich. (=*Sporobolus arabicus* Boiss.) has perhaps the least range, being confined to Sind, Punjab, and Baluchistan. *Suaeda fruticosa* Forsk. has also a more or less restricted distribution being confined to NW. India, W. Punjab, and W. India. It is perhaps *Scirpus affinis* Roth. that has the greatest range among the species, extending from Punjab in the west to Assam in the east. *Atriplex stocksii* Boiss. and *Scirpus affinis* Roth. show greater southerly distribution, extending to Hyderabad and Deccan. Some of the species of the western parts of India have their distribution extended to Arabia (*Sporobolus marginatus* Hochst. ex A. Rich.), Africa, and westwards to America (*Suaeda fruticosa* Forsk.), and to the Mediterranean (*Suaeda fruticosa* Forsk.). *Scirpus affinis* Roth., however, shows an opposite tendency extending further in the east to Burma, north China, and north Asia. It would seem to suggest that migrations from these parts of these species into north-east and west India in the past have not progressed much in the wide distribution of these species within India, except that *Atriplex stocksii* Boiss. and *Suaeda fruticosa* Forsk. have advanced further south. Likewise, *Sporobolus tremulus* Kunth, which has its distribution in Cambodia in the east, has advanced westwards to India and is now found in upper India as well as in all districts in Madras, except the west coast of India and the Ghats. Thus the occurrence in Church Island of the species with the hitherto known westerly distribution in America, Mediterranean, Africa, and Arabia, and confined to western and north-western parts of India, and the species known hitherto from the eastern Peninsula with the distribution in the east in north Asia, Cambodia, etc. would seem to suggest that, in this part of the Peninsula, there is perhaps a convergence of the species native to the regions eastern and western relative to India.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MEDITERRANEAN
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ARABIA
AMERICA
AFRICA
TUTICORIN
○▬ SPOROBOLUS MARGINATUS
●- - SUAEDA FRUTICOSA
△.... ATRIPLEX STOCKSII
×//// SCIRPUS AFFINIS
□═ SPOROBOLUS TREMULUS

Map showing the distribution pattern of some species

ACKNOWLEDGEMENT

The author wishes to express his grateful appreciation to Rev. Fr. H. Santapau, S.J., for his helpful suggestions and kind criticisms of the paper.

CHECK LIST OF THE SPECIES

LEGUMINOSAE
- *Indigofera viscosa* Lam.
- *I. oblongifolia* Forsk.
- *Phaseolus trilobus* Ait.
- *Acacia* sp.

AIZOACEAE
- *Sesuvium portulacastrum* Linn.

RUBIACEAE
- *Oldenlandia umbellata* Linn.

COMPOSITAE
- *Launaea sarmentosa* (Willd.) Alston.

GOODENIACEAE
- *Scaevola plumieri* Vahl.

SALVADORACEAE
- *Salvadora persica* Linn.

GENTIANACEAE
- *Enicostemma verticillatum* (Linn.) Eng.

CONVOLVULACEAE
- *Ipomoea pes-caprae* (Linn.) Sweet.

CHENOPODIACEAE
- *Atriplex stocksii* Boiss.
- *Arthrocnemum indicum* Moq.
- *Suaeda monoica* Forsk.
- *S. fruticosa* Forsk.

EUPHORBIACEAE
- *Euphorbia* sp.

LILIACEAE
- *Aloe barbadensis* Mill.

CYPERACEAE
- *Pycreus odoratus* Urb.
- *Cyperus pachyrrhizus* Nees.
- *C. arenarius* Retz.
- *Bulbostylis barbata* Kunth.
- *Scirpus affinis* Roth.

GRAMINEAE
- *Spinifex littoreus* (Burm. f.) Merr.
- *Dichanthium annulatum* (Forsk.) Stapf.
- *Halopyrum mucronatum* Stapf.
- *Sporobolus tremulus* Kunth.
- *S. marginatus* Hochst. ex A. Rich.
- *S. indicus* R. Br.

A Study of the Seasonal Foods of the Black Francolin[1] [*Francolinus francolinus* (Linnaeus)], the Grey Francolin[1] [*F. pondicerianus* (Gmelin)], and the Common Sandgrouse (*Pterocles exustus* Temminck) in India and Pakistan

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The conservation and wise use of our natural resources is important to everyone. The value of good soil, adequate water, and abundant forests to the country, although well known to the technical man, is just beginning to be understood by a small part of the general public. Only a handful of people appreciate the need for protecting and maintaining our birds and mammals, especially the species that provide hunting and are used for food.

No plan for making our renewable natural resources more productive can succeed for long unless it is based on an adequate study of the factors that produce these resources. For example, with game species one must know not only how much hunting pressure they can take and still produce a good crop of game the following year, but also where they live, what they eat, how they are affected by floods and drought, and what are their natural enemies. Only when one has reliable information on these and other factors, can a well-thought-out plan be developed.

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[1] The popular names in use in India and Pakistan for *F. francolinus* and *F. pondicerianus* are Black Partridge and Grey Partridge respectively. In this paper the authors have used the names Black Francolin and Grey Francolin in order to avoid confusion with certain other species existing in America and spoken of there as partridges.—EDS.

It was with this in mind that the authors made a study of the food habits of three species of game birds that are common in India and Pakistan. Except for C. W. Mason, an entomologist, who in 1912 reviewed the few references available and contributed an excellent list of insects found in the crops of Black Francolin, very little definite information is available. The other authors, listed in the references, either mention the food habits of the francolins and the sandgrouse in general terms or list one or two specific species which are commonly eaten.

The data here presented are based on an examination of the crop contents of 23 Black Francolin [*Francolinus francolinus* (Linnaeus)], 54 Grey Francolin [*Francolinus pondicerianus* (Gmelin)], and 47 Common Sandgrouse (*Pterocles exustus* Temminck). These birds were collected mostly in Sind (Pakistan) in 1956-57, and Rajasthan (India) in 1959-60, during the spring, summer, fall, and winter months. Though additional crops are desirable it is felt that the records so far obtained indicate the general food habits of the species involved and should be of beneficial use to the wildlife manager. Our hope is that this paper will, even in a modest way, stimulate additional studies which will lead towards a balanced game management programme for these species.

Since the collection of crops was made only as opportunity offered, the distribution of birds collected by seasons leaves room for further investigation. The seasons utilized were chosen after consultation with appropriate Government officials and local naturalists. In the areas concerned, spring and fall blend into summer and winter more quickly than in more temperate climates. Plants reflect these changes. Accordingly spring was designated as occurring between March 1-April 15 ; summer, April 16-September 15 ; fall, September 16-October 31 ; and winter, November 1-February 28. Based on this, the following is the distribution of birds collected by seasons :

Species	*Number collected by seasons*				
	Spring	*Summer*	*Fall*	*Winter*	*Total*
Black Francolin	5	8	1	9	23
Grey Francolin	0	28	7	19	54
Common Sandgrouse	6	14	11	16	47

Since no adequate collection of the seeds of wild plants was available for reference it was necessary to check many of the identifications by actually collecting the same seeds from wild plants in the countryside. In some cases the seeds taken from the crops of the birds were planted first in pots and identified only after the resulting plant had grown to maturity. The identification of the insects eaten are given, in most cases, down to the order and family.

FOOD OF THE BLACK FRANCOLIN

All the Black Francolin examined were collected from Sind (West Pakistan). The study indicates clearly that this species is omnivorous. A total of 19 different genera of plants and 4 orders (including 12 species) of insects were found in the crops examined. In addition, one bird had eaten an earthworm, one a spider, two more had fed almost entirely on human excrement, and one, collected after a rainstorm, had swallowed an inch and a half toad. Of the 23 birds examined two had consumed insects only, 9 plants only, and 12 had eaten both.

Insects are eaten at all seasons of the year. Ants and beetles were commonly found in the crops, although wasps and flies were also identified. One bird, collected in August, had eaten 21 ants, 1 earthworm, 4 unidentified larvae, about 500 small pink midges, and a spider.[1]

Plants, however, make up the bulk of the food of the Black Francolin throughout the year. Seeds of mustard (*Brassica campestris*), wild pea (*Lathyrus sativus*), cultivated grain, and grass seed were most commonly eaten. Parts of 20 different species of plants were identified which included seeds, fruits, tubers, grains, leaves, and a small amount of roughage in the form of twigs, husks, and dried grasses.

In winter the wild pea and the common mustard are favourite foods. One bird shot in February had made a meal of 250 wild peas ; another, of over 300 mustard seeds with some leaves from the same species.

In spring, with the harvesting of the winter grains underway, the birds often turn their attention to wasted wheat (*Triticum vulgare*), barley (*Hordeum* sp.), and rice (*Oryza sativa*) whenever they are available, although other seeds are by no means avoided. One bird, collected in April, had scratched up and eaten 12 large tubers of a desert sedge (*Cyperus arenarius*) and others had fed largely on wild peas.

It is during the summer and fall, however, that the Black Francolin seeks out a great variety of plant foods. Most of those mentioned above were commonly found in the crops examined, but the largest number of seeds and inflorescences were from four genera of grasses that ripened at this time. One individual, collected in September, had a full crop of 1850 grass seeds representing four species, 250 seeds of Indian mallow (*Abutilon* sp.), one seed of *Rhynchosia* sp., and five other seeds, still unidentified. Another bird, shot in October, had consumed about 1000 seeds of *Setaria verticillata* and 54 seeds of three other grass species.

Table I gives the seasonal analysis of foods eaten.

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[1] Grasshoppers were commonly found in the crops of Black Francolin collected by one of the authors in Iraq in 1951. Ticehurst, Buxton, & Cheesman (1922) record one crop that was crammed with the harmful locust *Decticus albifrons*.

TABLE I

Foods eaten by the Black Francolin according to Season and number of Crops in which each was found

Food		Parts eaten	Season			
			Spring	Summer	Fall	Winter
PLANT						
Abutilon sp. ..	Indian Mallow	Seeds		1		
Brassica campestris ..	Mustard	Seeds				2
Cephalandra indica ..	a cucurbit	Seeds		1		
Cyperus arenarius ..	Flat Sedge	Rhizome	1			
Dactyloctenium aegyptium	a grass	Seeds		1		
Dactyloctenium scindicum ..	a grass	Inflorescence		1		
		Seeds		1	1	
Echinochloa colonum ..	Jungle Rice	Peduncle			1	
		Seeds		2	1	
Eriochloa procera ..	a wild millet	Inflorescence		2		
Hordeum sp. ..	a barley	Seeds	3			
Lathyrus sativus ..	Wild Pea	Seeds	1			7
Lathyrus sp. ..	a pea	Seeds	1			
Launaea nudicaulis ..	a compositae	Inflorescence				1
		Leaves				1
Mukia scabrella ..	a cucurbit	Fruits		2		
		Seeds		2		
Oryza sativa ..	Rice	Seeds	3	3		
Panicum miliaceum ..	Broom Corn Millet	Seeds	1			
Pennisetum typhoideum ..	Bajra, a millet	Seeds	1			
Phaseolus mungo ..	Pulse	Seeds		1		
Rhynchosia sp. ..	a legume	Seeds		1		
Setaria verticillata ..	Bristlegrass	Seeds		1	1	
Solanum nigrum ..	Black Nightshade	Fruit				1
Triticum vulgare ..	Wheat	Glumes	1			
		Leaves				1
		Seeds	2	1		
ANIMAL						
Hymenoptera ..	Small black ants	Whole		3		
	Medium black ants	Whole	5	1		1
	Large black ants	Whole	1	1		
	Red ants	Whole	1	1		
	Wasp	Whole		1		
Diptera ..	Fly	Whole		1		
	Midge	Whole		1		
Coleoptera ..	Small black beetles	Whole		1		1
	Medium black beetles	Whole		1		
	Large black beetles	Whole	1	1		
	Striped beetle	Whole				1
	Brown beetle	Whole	2			
Araneae ..	Spider	Whole		1		
Pheretima sp. ..	Earthworm	Piece		1		
Bufo sp. ..	Toad	Whole	1			
MISCELLANEOUS						
	Human excrement					2
	Grit					1

FOOD OF THE GREY FRANCOLIN

Of the 54 birds examined 38 were collected from western India and 16 from West Pakistan. Like the Black, the Grey Francolin is omnivorous. Of the crops examined 23 contained only plant material, one only insects, and in 30 both plant and animal items were found. From these, 33 species of plants and 7 orders of insects were identified. Miscellaneous items eaten included fragments of coal, baked bricks, grit, and snail shells. Animal material, other than insects, was limited to a few solifugids and spiders.

A great variety of weed seeds with some cultivated grain made up the bulk of the plant food. Members of the grass family are also well represented. Seeds were the prominent form of the plant food eaten. The variety and quantity of food taken is surprising. For example, one crop collected in upper Sind on February 26 contained 1 wheat seed (*Triticum vulgare*), 1 of wild melon (*Citrullus colocynthis*), 1500 of *Dactyloctenium scindicum*, 2000 of jungle rice (*Echinochloa colonum*), 4 of *Abutilon* sp., 5 of cockscomb (*Celosia* sp.), 1 unidentified seed, 1 green leaf, 1 large black beetle, 1 small beetle, and 2 termites. Another crop collected in Rajasthan in July contained green grass blades, hundreds of termite larvae (white ants), 6 cutworms, 18 tenebrionids, 3 carabids, 8 hydrophillids, 3 weevils, and grit.

Insect food was taken abundantly in the summer with the Grey Francolin showing a high preference for ants and termites. Interestingly enough beetles, some of which were of large size, comprised a substantial portion of the diet. In winter, where mustard is available, it is a favourite food.

The analysis of foods eaten in summer, fall, and winter is presented in Table II. No birds were collected in the short period represented by spring.

TABLE II

Foods eaten by the Grey Francolin according to Season and number of Crops in which each was found

Foods		Parts eaten	Season		
			Summer	Fall	Winter
PLANT					
Abutilon sp. ..	Indian Mallow	Seeds	1		2
Acacia sp. ..		Seeds	4		
Brassica campestris ..	Mustard	Flower buds			3
		Flowers			2
		Pods			1
		Seeds			2
		Leaves			4
Capparis aphylla ..		Seeds	9		4
Celosia sp. ..	Cockscomb	Seeds			4
Cephalandra indica ..	a cucurbit	Fruit skin	1		
		Seeds	1		

Food		Parts eaten	Season		
			Summer	Fall	Winter
Citrullus colocynthis	Wild Watermelon	Seeds	2		1
Cyperus rotundus	Flat Sedge	Rhizome	1		
Dactyloctenium aegyptium	a grass	Seeds	1		
Dactyloctenium scindicum	a grass	Spikelets			1
		Seeds	1		4
Echinochloa colonum	Jungle Rice	Seeds	4		2
Eragrostis minor	a lovegrass	Seeds		3	
Eriochloa procera	a wild millet	Seeds	4		2
Farsettia jacquemontii	a cruciferae	Flower buds			3
		Pods			4
		Seeds	1		1
Gynandropsis gynandra		Seeds	3		2
Indigofera sp.	Indigo	Seeds			2
Lathyrus sativus	Wild Pea	Seeds			1
Launaea nudicaulis	a compositae	Inflorescence			3
		Leaves			1
Mukia scabrella	a cucurbit	Fruit skin	2		
		Seeds	2		
Panicum antidotale	Panicgrass	Seeds	1		1
Panicum turgidum	Panicgrass	Seeds	8	5	1
Pennisetum typhoideum	Bajra, a millet	Seeds	6		4
Phaseolus aconitifolius	Pulse	Seeds	1		3
Phaseolus radiatus	Pulse	Seeds			2
Rhynchosia sp.	a legume	Seeds			1
Scirpus sp.	Bullrush	Rhizome	2		
Setaria verticillata	Bristlegrass	Seeds	1		
Solanum nigrum	Black Nightshade	Fruit			1
Sorghum sp.	Sorghum	Seeds	4	3	1
Tephrosia purpurea	a legume	Seeds			3
Tribulus sp.		Seeds			1
Triticum vulgare	wheat	Seeds	2		1
Zizyphus sp.	Jujube	Fruit	4		
Unidentified	Grass	Blades	8	3	1
ANIMAL					
Hymenoptera	Ants	Whole	10	1	5
Isoptera	Termites—adult and larvae	Whole	10		1
Coleoptera	Beetles	Whole			3
Scarabidae	a beetle	Whole	4		2
Tenebrionidae	a beetle	Whole	5	1	
Hydrophyllidae	a beetle	Whole	5	1	
Carabidae	a beetle	Whole	5	1	
Elateridae	Click beetles	Whole	1		
Buprestidae	a beetle	Whole	1		
Curculionidae	Weevils	Whole	4		
Lepidoptera					
Noctuidae	Cutworms	Whole	3	1	
Orthoptera	Grasshoppers, Crickets	Whole	2		1
Homoptera	Bugs	Whole	2		
Diptera	Flies	Whole	1		
Solifugae		Whole	2		
Araneae	Spiders	Whole	1		
MISCELLANEOUS					
	Grit	Pieces	9	4	4
	Snail shells	Whole	1		
		Pieces			2
	Coal	Pieces			2
	Baked brick	Pieces			2

FOOD OF THE COMMON SANDGROUSE

Seven of the Common Sandgrouse examined were collected within 40 miles of Karachi (West Pakistan) and 40 were from western India, mostly from about Jodhpur, Delhi, and Poona.[1] This sample indicates that the food habits of this species are much different from those of the francolins previously examined. No insects were found, the diet, apparently, being restricted almost entirely to seeds.[2] Interestingly enough the majority of the seeds eaten were leguminous, and those species most abundantly taken (the *Indigoferae*) are extremely small seeds. In contrast to the francolins which take some cultivated grains and seeds of weeds often associated with agriculture, the sandgrouse prefers the seeds of wild plants. Thus the bird is in no way dependent upon agriculture and can therefore inhabit the more arid regions of India and Pakistan. The sandgrouse does not entirely ignore cultivated grains, however, as is shown by the presence of several cultivated seeds (*Phaseolus* and *Cyamopsis*) in minor quantities. The *Tephrosiae* which offer a fair-sized seed in contrast to the minute *Indigoferae* are also one of the favourite foods.[3]

Substantial quantities of seeds are consumed as can be seen by the following examples. In the crop of one bird, collected on March 12 near Karachi (Pakistan), there were about 5600 seeds of *Indigofera cordifolia*, 51 seeds of *Tephrosia tenuis*, 89 of *Indigofera uniflora*, and 9 of *Indigofera anabaptista.* The crop of another bird, collected on February 8 at Sambhar Lake, Rajasthan (India), contained about 10,000 seeds of *Indigofera linifolia*, 350 of *Crotalaria* sp., 1 of *Tephrosia strigosa*, 2 of *Panicum* sp., 1200 of *Gynandropsis gynandra*, 1 of *Tephrosia purpurea*, 5 of *Phaseolus radiatus*, and slightly over 100 seeds of species as yet unidentified.

The analysis of the foods eaten in the spring, summer, fall, and winter is presented in Table III.

RELATION OF THESE SPECIES TO AGRICULTURE

In considering the food eaten by any wild bird or mammal one of the questions frequently raised is its effect on agriculture. Misconceptions on this point are common and many game mammals and some birds are often killed in the mistaken notion (or the excuse) that they seriously damage farm crops.

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[1] The authors gratefully acknowledge the considerable assistance of Fr. Joe Rodrigues in collecting sandgrouse for examination from the country east of Poona, his work being carried out with the aid of funds received by him from the Bombay Natural History Society out of a grant received by the Society from the Rockefeller Fund.

[2] Hume & Marshall (1880) found two insects in the crop of Common Sandgrouse.

[3] Jerdon (1864) records the Common Sandgrouse as feeding on various hard seeds especially those of various *Alysicarpi*, *Desmodium.* Hume & Marshall (1880) say that 'no small seeds seem to come amiss'; Baker (1921) mentions 'hard seeds and grain'; and an anonymous author refers to the seeds of the common thistle as a favourite food.

TABLE III

Foods eaten by the Common Sandgrouse according to Season and number of Crops in which each was found

Foods		Parts eaten	Season			
			Spring	Summer	Fall	Winter
PLANT						
Alysicarpus sp. ..		Seeds	2	3	5	
Amaranthus sp. ..	Amaranth	Seeds				1
Crotalaria sp. ..	Rattlewort	Seeds	1			6
Cyamopsis psoralioides ..		Seeds				2
Desmodium sp. ..	Beggarweed	Seeds				3
Euphorbia sp. ..	Spurge	Seeds		1		
Gynandropsis gynandra ..		Seeds				5
Heliotropium strigosum ..	a heliotrope	Seeds	2	6	7	4
Indigofera anabaptista ..	an indigo	Seeds	1	3		
Indigofera cordifolia ..	an indigo	Seeds	2	5	1	1
Indigofera enneaphylla ..	an indigo	Seeds			2	2
Indigofera linifolia ..	an indigo	Seeds	4	7	8	9
Indigofera uniflora ..	an indigo	Seeds	1	4	6	
Panicum antidotale ..	Panicgrass	Seeds				
Panicum sp. ..	Panicgrass	Seeds				5
Panicum turgidum ..	Panicgrass	Seeds			1	
Phaseolus aconitifolius ..	Pulse	Seeds				1
Phaseolus radiatus ..	Pulse	Seeds				4
Tephrosia purpurea ..	a legume	Seeds	4	6	3	6
Tephrosia sp. ..	a legume	Seeds			1	
Tephrosia strigosa ..		Seeds			5	10
Tephrosia tenuis ..	Hoary Pea	Seeds	2	2		
Unidentified ..	Grass	Blades	2	1		
MISCELLANEOUS ..	Grit	Pieces	3	5	6	6

None of the three species here considered normally falls in this category. Farmers, generally, are glad to have or are indifferent to the presence of francolin and sandgrouse on their lands. Their good judgment in this respect is amply borne out by the results of this study. These birds do very little, if any, damage to farm crops and the good, in terms of weed seeds and insects consumed by them, is not to be overlooked. From the food habits as well as the sporting point of view they are among the most desirable game birds resident on the Indian subcontinent.

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Notes on Shipworms from Visakhapatnam Harbour[1]

BY

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(*With four text-figures*)

In the course of a detailed study of the Teredinidae of Visakhapatnam harbour, the author (1955) was able to describe thirteen species belonging to the genera *Teredo* and *Bankia*. Though Teredines have been extensively studied in various countries, our knowledge of the tropical forms is very meagre. From Cochin harbour, Erlanson (1936) noted the occurrence of five species. Nair (1954, 1955a, and 1955b) reported seventeen species of shipworms from the Madras coast. Roonwal (1954) recorded the occurrence of *Bactronophorus thoracites* from the Sunderbans. Palekar & Bal (1955) described four species of *Teredo* and three species of *Bankia* from Bombay harbour. Nair & Gurumani (1956, 1957) described a new species of *Teredo* from south India.

The present communication deals with ten more shipworms collected from Visakhapatnam harbour. Out of these, five species are the first records from Indian waters. In the treatment of the species the classification given by Bartsch (1922) and Roch (1953, 1955) was followed.

Collections of specimens were made in the Visakhapatnam harbour waters during the years 1953-57 from timber jetties, catamaran logs used for fishing, and standard test boards of deal wood of various convenient sizes.

All drawings were made with the aid of the camera lucida.

SYSTEMATIC TREATMENT OF THE GROUP

Genus **Teredo** Linnaeus
  Subgenus TEREDO Linn
    1. **Teredo (Teredo) bensoni** Edmondson
  Subgenus COELOTEREDO Bartsch
    2. **Teredo (Coeloteredo) singaporeana** Roch

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[1] Formed part of the thesis for the D.Sc. Degree of Andhra University. Contribution from the Zoology Department, Andhra University, Waltair.

Subgenus DACTYLOTEREDO Roch
3. **Teredo (Dactyloteredo) juttingae** Roch

Subgenus LYRODUS Gould
4. **Teredo (Lyrodus) milleri** Dall, Bartsch, & Rehder
5. **Teredo (Lyrodus) malaccana** Roch

Genus **Bankia** Gray
Subgenus LILIOBANKIA Clench & Turner
6. **Bankia (Liliobankia) campanellata** Moll & Roch

Subgenus BANKIELLA Bartsch
7. **Bankia (Bankiella) carinata** Gray

Subgenus PLUMULELLA Clench & Turner
8. **Bankia (Plumulella) thielei** Roch
9. **Bankia (Plumulella) lineata** Nair

Genus **Nausitora** Wright
10. **Nausitora dunlopei** Wright

Genus **Teredo** Linnaeus

1758. *Teredo* Linnaeus, in Syst. Nat., ed. 10, p. 651.
1922. *Teredo* Bartsch, in *Bull. U.S. Nat. Mus.* **122** : p. 17.

Pallets are either paddle- or spoon- shaped. They may be distally cupped or not.

Subgenus TEREDO Linn.

1758. *Teredo* Linn., in Syst. Nat., ed. 10, p. 651.
1922. *Teredo* Bartsch, in *Bull. U.S. Nat. Mus.* **122** : p. 17.

Pallets paddle-shaped with the blade cupped distally terminating laterally in sharp points.

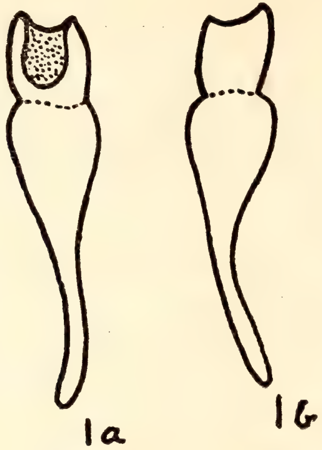
Teredo (Teredo) bensoni Edmondson

1946. *Teredo* (*Teredo*) *bensoni* Edmondson, in *Occas. Papers B.P. Mus.* **18** : p. 213.

Pallets paddle-shaped with stout, curved stalk ; blade short, broad and its basal portion gradually merges into the stalk. The distal portion of the blade excavated deeply on the outer surface, inner surface is smooth. Dark brown periostracum covers the blade nearly to its base.

Measurements : Pallets : total length 4.2 mm., out of which 3.5 mm. belongs to the stalk.

Distribution : Honolulu harbour ; very rare in Visakhapatnam harbour.



Teredo (*Teredo*) *bensoni*
Fig. 1a: Outer view of pallet × 13; Fig. 1b: Inner view of pallet × 13.

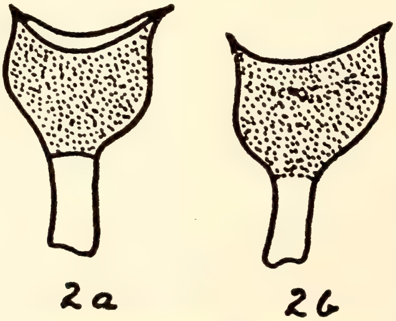
Subgenus Coeloteredo Bartsch

1953. *Coeloteredo* Bartsch, in *Proc. Biol. Soc. Wash.* **36** : p. 99.

In this subgenus the blade of the pallet forms a hollow cone ; that is, the outer portion is convex while the inner portion of the blade is almost flat.

Teredo (Coeloteredo) singaporeana Roch

1935. *Teredo* (*Coeloteredo*) *singaporeana* Roch, in Roch & Moll *Sitz. Ber. Akad. Wien. Wiss. Math. Natw. Kl. Abt.* I. **144** : p. 266.



Teredo (*Coeloteredo*) *singaporeana*
Fig. 2a: Pallet outer view × 12 ; Fig. 2b: Pallet inner view × 12.

Pallets with decidedly cup-shaped depression at the distal end. The distal portion is covered with a dark epidermis, which terminates in the form of two lateral horns. Stalk is shorter than the blade and is very stout at the base.

Measurements: Length of stalk 1.3 mm., length of blade 1.7 mm.

Distribution: Singapore, Sumatra, Madagascar, East Africa, Malacca ; rarely found in Visakhapatnam harbour.

Subgenus DACTYLOTEREDO Roch

1941. *Dactyloteredo* Roch, in Moll *Sitz. Ber. Ges. Natforsch. Freunde* **10** : p. 193.

1952. *Dactyloteredo* Roch, in Moll *Inst. Franç. Afrique Noire Catalogue* **8** : p. 83.

Pallets are oblong and leaf-shaped and provided with more or less nail-like depression on the outer side of the distal end of the blade.

Teredo (Dactyloteredo) juttingae Roch

1955. *Teredo* (*Dactyloteredo*) *juttingae* Roch, in *Zool. Meded.* **34**; p. 135.

Pallets with a blade which is shaped like a finger-nail but it is, however, comparatively smaller in area and does not extend up to the two side walls of the pallet. On the inner side, the blade is concave and smooth and shows a rib running through its centre very much as if the stalk portion extended towards the tip through the pallet. The stalk is very short and stout.

Measurements: Pallets : length of the blade 8 mm. ; length of the stalk 1.5 mm.

Distribution: Sumatra, Philippines, Samoa ; fairly common species in Visakhapatnam harbour and confined to the regions of higher salinities in the harbour area. It was also collected from Kakinada.

Subgenus LYRODUS Gould

1870. *Lyrodus* Gould, in *Invert. Mass.* p. 33.

In this subgenus the terminal portion is not cupped, but ends in two lateral forks, covered with a periostracum.

Teredo (Lyrodus) milleri Dall, Bartsch, & Rehder

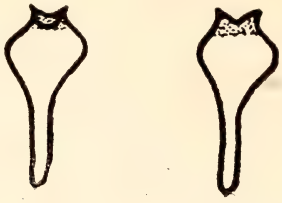
1924. *Teredo affinis* Miller, in *Univ. Calif. Pub. Zool.* **26** : p. 148.

1938. *Teredo* (*Cornuteredo*) *milleri* Dall, Bartsch, & Rehder, in *B.P. Mus. Bull.* **153** : p. 210.

1942. *Teredo* (*Cornuteredo*) *milleri* Edmondson, in *Occas. Papers B.P. Mus.* **17** (10) : p. 114.

1955. *Teredo* (*Lyrodus*) *milleri* Roch, in *Riv. Biol. Colon.* **13**.

Pallets with slender stalk ; blade consisting of a short, urn-shaped, calcareous base, surmounted by a dark brown periostracum which is typically two pointed.



3a 3b

Teredo (*Lyrodus*) *milleri*
Fig. 3a : Outer view of pallet × 17; Fig. 3b : Inner view of pallet × 17.

Measurements: Pallets : total length 1.4 mm. ; stalk 0.8 mm.

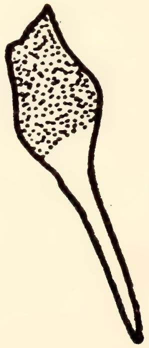
Distribution: Hawaii ; very rare in Visakhapatnam harbour.

Remarks: Only ten young immature specimens were collected from the test boards at Naval base in Visakhapatnam harbour.

Teredo (Lyrodus) malaccana Roch

1935. *Teredo* (*Lyrodus*) *malaccana* Roch, in *Sitz. Ber. Akad. Wiss. Wien. Math. Natw. KI. Abt.* I. **144** : p. 269-270.

1955. *Teredo* (*Lyrodus*) *malaccana* Roch, in *Zool. Meded.* **34** : p. 136-139.



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Teredo (*Lyrodus*) *malaccana*
Fig. 4 : Pallet, inner view × 10.

Pallets slender and typically of *Lyrodus* shape ; blade covered by dark brown periostracum which occupies greater portion of calcareous blade and is not produced into distinct lateral forks.

Measurements: Pallets : total length 4.1 mm. ; length of stalk 2.2 mm.

Distribution: Malaya, Indonesia, very few forms collected from the Visakhapatnam harbour.

Genus **Bankia** Gray

1840. *Bankia* Gray, in Synop. Brit. Mus. Ed. **42** : p. 154.
1922. *Bankia* Bartsch, in *Bull. U.S. Nat. Mus.* **122** : p. 7.

The pallets consisting of a series of cone-in-cone structures which give them the appearance of the ear of wheat.

Subgenus LILIOBANKIA Clench & Turner

1946. *Liliobankia* Clench & Turner, in Johnsonia **2** : p. 17.

Pallets have a moderately wide and smooth margin of periostracum which is produced laterally to form wide, blunt awns. The embryonic cones are not crowded at the tip of the pallet but are distally spaced.

Bankia (Liliobankia) campanellata Moll & Roch

1931. *Bankia* (*Liliobankia*) *campanellata* Moll & Roch, in *Proc. Malac. Soc. Lond.* **19** : p. 215.
1955. *Bankia* (*Liliobankia*) *campanellata* Roch, in *Zool. Meded.* **34** : p. 140.

Pallets consisting of a series of widely spaced cones ; calcareous portion of each cone funnel-shaped ; periostracal margin of the outer surface slightly U-shaped and smooth while the inner margin is flat ; laterally the periostracum is produced into wide, blunt awns which are curved upwards.

Measurements: Pallets : total length 30 mm., of which 15 mm. go to form the stalk.

Distribution: Malaya Archipelago, Sumatra ; most common species of *Bankia* in Visakhapatnam harbour.

Subgenus BANKIELLA Bartsch

1921. *Bankiella* Bartsch, in *Proc. Biol. Soc. Wash.* **34** : 26.

Pallets consisting of a series of cone-in-cone elements covered by a thin membrane which is neither fimbriated nor denticulated at the free margin, but entire.

Bankia (Bankiella) carinata Gray

1827. *Bankia carinata* Gray, in *Phil. Mag.* **2** : p. 411.
1954. *Bankia* (*Bankiella*) *indica* Nair, in *Rec. Ind. Mus.* **52**, (2-4) : p. 393-396.
1955. *Bankia* (*Bankiella*) *carinata* Roch, in *Zool. Meded.* **34** : p. 139.

Pallets with cone-in-cone type joints which are funnel-shaped ; the blade consists of well-spaced cups, the rims of which are covered by brown periostracum ; the outer side of the blade is convex and the inner side flat, Measurements: Pallet length 9.5 mm. ; length of stalk 5.0 mm.

Distribution: Indonesia, Malacca ; in India this species was previously recorded from Calcutta, Bombay, and Madras ; very rare in Visakhapatnam harbour.

Subgenus PLUMULELLA Clench & Turner

1946. *Plumulella* Clench & Turner, in Johnsonia **2** : p. 24.

Pallets have long serrated awns. The periostracal margins on both the inner and outer surfaces of each cone are finely to coarsely serrated.

Bankia (Plumulella) thielei Roch

1935. *Bankia* (*Plumulella*) *thielei* Roch, in Roch & Moll *Sitz. Ber. Akad. Wiss. Wien. Math. Natur. Abt.* I. 144 : p. 275.

1955. *Bankia* (*Plumulella*) *thielei* Roch, in *Riv. Biol. Colon.* **13**.

Pallets consisting of closely-spaced cones ; the periostracal margin of the outer and inner surfaces is coarsely-serrated ; stalk is approximately of equal size as the blade of the pallet.

Measurements: Pallets : total length 11 mm., of which 5.8 mm. go to form the stalk.

Distribution: Madagascar ; only two pallets were collected once at entrance channel in Visakhapatnam harbour.

Bankia (Plumulella) lineata Nair

1955. *Bankia* (*Neobankia*) *lineata* Nair, in *J. Madras Univ.* **25**: p. 109.

This species was first described by Nair (1955) and included under the subgenus *Neobankia* ; but according to the classification given by Clench and Turner (1946) for the genus *Bankia*, it belongs to the subgenus *Plumulella*, as the pallets possess long serrated awns.

Pallets feather-shaped with a cylindrical stalk ; the blade consists of distinct cone-in-cone structures, the lateral borders of which are drawn out into slender awns ; the inner margin of each cone forms a slender cup while the outer margin is deeply concave.

Measurements: Pallet length 9.2 mm. ; length of stalk 4.0 mm.

Distribution: Madras ; only few pallets were collected from naval base in Visakhapatnam harbour.

Genus **Nausitora** Wright

1864. *Nausitora* Wright, in *Trans. Linn. Soc. Lond.* **24** : p. 456.

Pallets consisting of a series of cone-in-cone elements which are not entirely free at their distal ends, but fused on the exterior surface,

Nausitora dunlopei Wright

1864. *Nausitora dunlopei* Wright, in *Trans. Linn. Soc. Lond.* **24**: p. 451.

Pallets with a cylindrical stalk which is curved and tapers to a fine sharp point; the outer surface of the blade is convex and roughly imbricated; on the inside the blade shows a series of transverse laminae.

Measurements: Pallets: length of blade 8 mm.; length of stalk 5 mm.

Distribution: Australian waters; rare in Visakhapatnam harbour, also recorded from Madras and Hooglee River.

SUMMARY

The present survey extends our knowledge of shipworms from Visakhapatnam harbour over previous records by listing ten more species. Of these five species *Teredo* (*Teredo*) *bensoni*, *Teredo* (*Coeloteredo*) *singaporeana*, *Teredo* (*Lyrodus*) *milleri*, *Teredo* (*Lyrodus*) *malaccana*, and *Bankia* (*Plumulella*) *thielei* are recorded for the first time from Indian waters.

Teredo (*Dactyloteredo*) *juttingae* and *Bankia* (*Liliobankia*) *campanellata* are of very common occurrence in Visakhapatnam harbour.

ACKNOWLEDGEMENTS

The author is grateful to Prof. P. N. Ganapati for his guidance. Thanks are also due to Dr. F. Roch for kindly examining the shipworms and to Dr. C. H. Edmondson for sending some of the shipworms from Hawaii for comparison with the local forms. This work was carried out with the funds provided by the Forest Research Institute, Dehra Dun, specially obtained from various sources for the execution of the scheme for the protection of timber against attack by marine organisms.

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The Vegetation of Marshes, Swamps, and Riverside in Khandwa District (Madhya Pradesh)

BY

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INTRODUCTION

Although floristic and ecological studies on other types of Indian vegetation have been pursued in our country, the vegetation of rivers, marshes, and swamps has not received enough attention. This type of vegetation is of great botanical interest, and investigations carried out in England and America have yielded useful and significant results on the floristic composition, ecology, distribution, and phenology of this interesting group of plants (see Arber, 1920 ; Fassett, 1940 ; Muenscher, 1944). On Indian hydrophytes, except for the works of Dudgeon (1920), Saxton (1924), Biswas & Calder (1937), Misra (1940), and Mirashi (1954, 1957, 1958), there seems to be very little work done on the aquatic and marsh flora, and particularly there is no record of any ecological or floristic work on the aquatic and marsh plants of new Madhya Pradesh. In fact, the systematic study of the flora in this State has received very scant attention. There are exhaustive floras for Bihar, Madras, Bombay, and Uttar Pradesh. There is none for Madhya Pradesh (*see* Hewetson, 1951), and only partial check-lists have been prepared by Hole (1906), Biscoe (1910), Graham (1911, 1913), Witt (1911, 1916), Haines (1916), and Tiwari (1954, 1955).

It was, therefore, thought proper to make a detailed floristic survey of the aquatic and marsh vegetation of the various parts of Madhya Pradesh. A beginning has been made with the study of the hygrophilous vegetation of Khandwa district.

The present work is based on a number of excursions made by me at various seasons during the years 1958 and 1959, and is confined mainly to the angiospermic flora of the district.

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GEOGRAPHY, CLIMATE, AND FOREST VEGETATION

The Khandwa plateau is situated between 21° 50′-22° 25′ N. and 75° 57′-77° 13′ E. in the Narbadda Division of Madhya Pradesh. It is bounded on the north by the old Indore State, on the west by Indore and the Khandesh district of Bombay, on the south by Khandesh, Amraoti, and Akola districts of the new Bombay State, and on the east by the Hoshangabad and Betul districts. The fertile valleys of the Abna and Sukta rivers lie in the southern part of the Khandwa district. The main range of the Satpuras crosses the district in the southern part, with a width of about eleven miles and rather low elevation, from which a few peaks including that of Asirgarh rise conspicuously. The Khandwa plain has an elevation of about 850 ft. (260 m.) above sea-level.

The Khandwa climate is somewhat cooler than that of Nagpur in the summer and has practically the same temperature during the rains. The cold weather, though not bracing, is distinctly pleasant and lasts from the beginning of November to the middle of March. The hot winds usually begin about the middle of April and blow steadily from directions between north-west and west. Table I gives the climatic data on rainfall and temperature for the years 1950 to 1957. The maximum rainfall for the years given in Table I occurred in 1955, with 44.2 inches or 1121.7 mm., the minimum in 1953 with 15.9 inches or 403 mm. ; the average for these years is 31.9 inches or 812.6 mm., of which more than three-fourths falls between June and October. January is the coldest month of the year. In this month, the mean maximum and mean minimum temperatures are lowest being 29.4° C. and 10.7° C. respectively. The highest maximum temperature of 43.2° C. was recorded in the month of May 1954. The data on relative humidity were not available, as there is no recording station in the area surveyed by me. However, the area is one of the driest in the State and is characterized by low relative humidity.

TABLE 1

CLIMATOLOGICAL DATA FOR 1950-1957 [1]

Year	Annual Rainfall in mm.	Maximum temp. in degrees C.	Minimum temp. in degrees C.
1950	1092.7	41.8	11.7
1951	765.8	42.0	8.8
1952	721.6	42.5	11.0
1953	403.0	41.9	10.1
1954	767.0	43.2	11.5
1955	1121.7	41.9	10.8
1956	1064.0	40.9	11.0
1957	564.9	41.0	12.0

[1] The data were supplied by the District Statistical Office, Nimar, M.P.

GENERAL DESCRIPTION OF VEGETATION

The common habitats of the aquatic and marsh species in this area are a number of natural and artificial tanks and 'kunds' (Rameshwar, Suraj, Padma, and Bhim Kunds), the rivers Abna, Sukta, and Bham and their tributaries, irrigation channels, temporary ponds, and puddles. The Abna and Sukta rivers flow in the southern part of the Khandwa district and maintain a rich, hydrophytic flora. The plants, to name some of them, *Ottelia alismoides* Pers., *Vallisneria spiralis* L., *Hydrilla verticillata* Royle, *Ceratophyllum demersum* L., *Potamogeton perfoliatus* L., *P. indicus* Roxb., *P. pectinatus* L., *Zannichella palustris* L., *Naias minor* All., *Nymphoides cristatum* Ktze., *Lemna paucicostata* Hegelm., *Marsilea quadrifolia* Linn., *Hygrorhiza aristata* Nees, *Ipomoea aquatica* Forsk., *Rottboellia exaltata* L., *Hemarthria compressa* R. Br., *Ischaemum rugosum* Salisb., *Saccharum spontaneum* L., *Scirpus tuberosus* Desf., *S. erectus* Poir., *Cyperus alopecuroides* Rottb., *C. pygmaeus* Rottb., *C. difformis* L., *Fimbristylis complanata* Link, *F. dichotoma* Vahl, *Bacopa monnieri* Penn., *Phyla nodiflora* Greene, *Eclipta prostrata* L., *Exacum pedunculatum* L., *Canscora diffusa* R. Br., *Enicostemma verticillatum* Engl., *Hoppea dichotoma* Willd., *Polygonum plebejum* R. Br., *P. glabrum* Willd., and *P. hydropiper* L., mainly constitute the vegetation of Abna and Sukta rivers and their embankments.

In the neighbourhood of temporary ponds, puddles, and ditches, a rich marsh flora is recognizable. The common species are : *Justicia quinqueangularis* var. *peploides* C.B.Cl., *Hoppea dichotoma* Willd., *Marsilea quadrifolia* L., *Asteracantha longifolia* Nees, *Ammannia baccifera* subsp. *baccifera* Cuf., *Caesulia axillaris* Roxb., *Ageratum conyzoides* L., *Xanthium strumarium* L., *Eclipta prostrata* L., *Polygonum plebejum* R.Br., *Ludwigia parviflora* Roxb., *Alysicarpus bupleurifolius* DC., *Sesbania bispinosa* F. &. R., *Bacopa monnieri* Penn., *Sopubia delphinifolia* G. Don, *Heliotropium strigosum* Willd., *Ipomoea aquatica* Forsk., *Alternanthera sessilis* R.Br., *Euphorbia hypericifolia* L., *Phyllanthus maderaspatensis* L., *Commelina benghalensis* L., *C. hasskarlii* Cl., *Lemna paucicostata* Hegelm., *Wolffia* sp., *Scirpus roylei* Park., *Scleria tessellata* Willd., *Fimbristylis dichotoma* Vahl, *Cyperus iria* L., *C. compressus* L., *Andropogon pumilus* Roxb., *Brachiaria eruciformis* Griseb., *Eriochloa procera* Hubb., *Paspalum distichum* L., *Paspalidium flavidum* A. Camus, and *Echinochloa colona* Link. However, plants like *Justicia quinqueangularis* var. *peploides* C.B.Cl., *Caesulia axillaris* Roxb., *Xanthium strumarium* L., *Bacopa monnieri* Penn., *Alternanthera sessilis* R.Br., *Commelina hasskarlii* Cl., *Lemna paucicostata* Hegelm., *Wolffia* sp., and *Andropogon pumilus* Roxb. occur in pure stands, and the following communities are characteristic of the marsh flora of Khandwa :

(1) *Caesulia axillaris* community.

(2) *Asteracantha-Caesulia* community.

(3) *Justicia-Caesulia-Alternanthera* community.
(4) *Xanthium strumarium* community.
(5) *Andropogon pumilus* community.
(6) *Coix-Scleria* community.

ECOLOGICAL CLASSIFICATION

The hydrophytes of Khandwa can be classified into the following six life-forms on the basis of their contacts with soil, water, and air :

(1) *Free-floating hydrophytes.* These are in contact with water and air only. They are represented by algae like *Spirogyra*, ferns like *Azolla pinnata* R.Br., and angiosperms like *Lemna paucicostata* Hegelm., *Wolffia, Trapa bispinosa* Roxb., *Hygrorhiza aristata* Nees, and *Pistia stratiotes* L., *Ipomoea aquatica* Forsk., an amphibious herb, grows only in shallow water forming a dense network of branches.

(2) *Suspended hydrophytes.* These are rootless, submerged hydrophytes that are in contact with water only, e.g. *Ceratophyllum demersum* L. This species grows in shallow waters, often forming a pure association.

(3) *Attached submerged hydrophytes.* These are, entirely or for the most part, in contact with soil and water only. In some of these, e.g. *Naias minor* All., even the flowers are completely submerged. Others, like *Hydrilla verticillata* Royle, *Vallisneria spiralis* L., *Potamogeton crispus* L., and *P. perfoliatus* L., have their vegetative shoots under water, but the flowers are raised to or slightly above the surface of water. These species occur in pure stands, forming tangled masses of vegetation.

(4) *Attached hydrophytes with floating leaves.* These are in contact with soil, water as well as air. Here are included species like *Potamogeton indicus* Roxb., *Nymphoides cristatum* Ktze., and *Ottelia alismoides* Pers., which are either heterophyllous or possess only the floating leaves.

(5) *Emergent, amphibious hydrophytes.* The root, the lower part of the stem and, in some cases, even the lower leaves of these hydrophytes are usually submerged under water. *Sesbania bispinosa* F. & R., *Scirpus tuberosus* Desf., *Cyperus alopecuroides* Rottb., *Hemarthria compressa* R.Br., and *Ischaemum rugosum* Salisb. are some of the characteristic species of this group.

(6) *Wet-land hydrophytes.* These are rooted to the soil that is usually saturated with water, at least in the early part of their life. Here are included a large number of species of the Khandwa flora. *Ammannia baccifera* subsp. *baccifera* Cuf., *Caesulia axillaris* Roxb., *Eclipta prostrata* L., *Hoppea dichotoma* Willd., *Heliotropium strigosum* Willd., *Bacopa monnieri* Penn., *Justicia quinqueangularis* var. *peploides* Cl., *Asteracantha longifolia* Nees, *Phyla nodiflora* Gr., *Alternanthera sessilis* R.Br., *Polygonum plebejum* R.Br., *Commelina benghalensis* L., *C. hasskarlii* Cl.,

Cyperus pygmaeus Rottb., *C. difformis* L., *Scleria tessellata* Willd., *Fimbristylis dichotoma* Vahl, and *Andropogon pumilus* Roxb., are some of the characteristic species of this class of hydrophytes. Some of them continue to thrive even after the substratum has considerably dried up.

TAXONOMIC DATA

The aquatic and marsh vegetation of Khandwa comprises a rich and varied assemblage of vascular hydrophytes, besides a large number of algal forms including species of *Chara* and *Nitella*, which are usually found in association with the higher aquatic plants. On the basis of the author's own collections, the following taxonomic data are presented for the vascular hydrophytes of Khandwa:

Phylum	Class	Families	Genera	Species
PTERIDOPHYTA	Hydropteridineae	2	2	2
ANGIOSPERMAE	1. Dicotyledones	20	42	48
	2. Monocotyledones	9	35	47

ENUMERATION OF SPECIES

I. PTERIDOPHYTA

1. **Marsilea quadrifolia** L. An aquatic, amphibious herb. Common throughout in shallow water in ditches, moist banks of ponds, rivers, and marshy places.

2. **Azolla pinnata** R.Br. A free-floating aquatic plant. Common in Abna, Sukta, and Bham rivers, often associated with *Lemna* and *Wolffia*.

II. ANGIOSPERMAE

DICOTYLEDONES

CRUCIFERAE

3. **Rorippa indica** (DC.) Hochreut. An erect, glabrous or hairy annual. Flowers yellow. Found in marshes and swamps near ponds and puddles.
Local name : Khubkalan.
Flowers and Fruits : Dec.-July.

PORTULACACEAE

4. **Portulaca oleracea** Linn. A prostrate or ascending, succulent, glabrous herb. Flowers yellow. Common in marshes and swamps.
Local name : Nonia ; Golia.
Flowers and Fruits : Major part of the year.

TILIACEAE

5. **Corchorus olitorius** Linn. An erect, shrubby plant. Flowers yellow. Common along the margins of rivers and in marshes.
Local name : Sanp-ki-patti.
Flowers and Fruits : Sept.-Nov.

6. **Corchorus fascicularis** Lam. An erect, much-branched, glabrous herb. Flowers yellow. Common along the margins of ponds, puddles and ditches.
Flowers and Fruits : Sept.-Dec.

PAPILIONACEAE

7. **Sesbania bispinosa** (Jacq.) Fawc. & Rend. An erect, weak-stemmed shrub. Flowers yellow. Common along canal banks in marshes.
Local name : Chichida ; Jangli imli ; Dhandhan ; Silabhri.
Flowers and Fruits : Sept.-Nov.

8. **Desmodium triflorum** DC. A gregarious, trailing herb. Flowers pink or purplish. Occurs along the banks of rivers and canals.
Flowers and Fruits : During rains and early winter.

9. **Alysicarpus bupleurifolius** DC. A diffuse or ascending herb. Flowers pink. Common along canal banks.
Local name : Sewra ; Gahun-khad.
Flowers and Fruits : Aug.-Oct.

LYTHRACEAE

10. **Ammannia baccifera** L. subsp. **baccifera** Cuf. in *Bull. Jard. Bot. Brux. Suppl.* 29 (fasc. 3) : 607, 1959. An erect, glabrous herb. Flowers in condensed, axillary racemes or clusters. Capsules red when ripe. Common in marshes and along canal banks, often associated with sedges.
Flowers and Fruits : Sept.-Jan.

11. **Rotala tenuis** (Wt.) Koehne. A moisture-loving, tufted, elegant herb. Flowers rosy pink. Common on wet cliffs and rocky surfaces along the banks of Abna River.
Flowers and Fruits : Oct.-Feb.

ONAGRACEAE

12. **Ludwigia parviflora** Roxb. An erect, glabrous herb. Flowers yellow. Common along the banks of temporary ponds and puddles.
Flowers and Fruits : Aug.-Oct.

HYDROCARYACEAE

13. **Trapa bispinosa** Roxb. An aquatic herb. Flowers white. Cultivated in ponds for its edible fruit which is eaten raw or cooked.
Local name : Singhara.
Flowers : Sept.-Oct. *Fruits* : Sept.-Dec.

COMPOSITAE

14. **Gnaphalium luteo-album** L. subsp. **pallidum** (Lamk.) Maheshwari, comb. nov.

Gnaphalium pallidum Lamk. Dict. 2 : 750, 1790 ; Wall Cat. 2953, 1828, nomen ; DC. Prod. 6 : 230, 1837.

Gnaphalium orixense Roxb. in Hort. Beng. 101, 1814, nomen ; Fl. Ind. 3 : 425, 1832.

Gnaphalium luteo-album L. var. α C. B. Clarke in Comp. Ind. 114, 1876.

Gnaphalium luteo-album L. var. *pallidum* Hook. f. in Fl. Brit. Ind. 3 : 288, 1881 ; Hochreut. in Candollea 5 : 313, 1934.

This plant is listed in our floras under the name of *Gnaphalium luteo-album* L. var. *pallidum* Hook. f. Recently, Koster (in Blumea 4 : 484, 1941), following C. B. Clarke (loc. cit.) and Hochreutiner (loc. cit.), has shown that there are two subspecific entities under *G. luteo-album* L. The above new combination is proposed for the plant which is found throughout the Gangetic plains and in central India. It also occurs in west Java, Australia, New Guinea, Philippines, Indo-China, Madagascar, Mauritius, Africa, and Europe.

The differences between the two subspecies are as follows :

Involucral bracts citrine to golden yellow ; capitula 3-3.5 mm. long ; a montane plant, rare on the plains....	*G. luteo-album* ssp. *affine* Kost.
Involucral bracts pale to dark brown or reddish brown ; capitula 3.5-4.5 mm. long ; common on the plains.	*G. luteo-album* ssp. *pallidum* Mahesh.

An erect, annual, woolly herb. Leaves 2.5-5 × 0.5-1 cm., lanceolate to oblong-spathulate, white-woolly on both surfaces. Capitula 3.5-4,5 mm. long, shining, in terminal and axillary corymbs or fascicles, heterogamous. Involucral scales pale to dark brown or reddish brown, oblong, obtuse. Common along the banks of rivers and near temporary ponds.

Flowers and Fruits : Cold and early summer seasons.

15. **Gnaphalium indicum** L. An erect or bent, white-woolly, polymorphic herb. Heads pale brown. Found along the banks of Abna and Sukta rivers in moist, sandy soils.
Flowers and Fruits : Dec.-April.

16. **Ageratum conyzoides** L. An erect, hairy, annual herb. Heads white, fragrant. Common along the banks of Abna River and other irrigation channels.
Flowers and Fruits : Oct.-June.

17. **Caesulia axillaris** Roxb. A prostrate or suberect, marshy herb. Florets whitish. Common in marshy places near temporary ponds, forming either pure or mixed communities ; in the latter case associated with *Asteracantha longifolia* Nees, *Alternanthera sessilis* R. Br., and *Justicia quinqueangularis* var. *peploides* Cl.
Flowers and Fruits : Oct.-April.

18. **Xanthium strumarium** L. A scabrous, erect, tall herb or undershrub. Common in the seasonal marshes of temporary ponds ; often gregarious. The leaves are eaten by goats.
Local name : Ghokhru ; Bhatoi ; Kateya.
Flowers and Fruits : Sept.-Nov. ; April.

19. **Eclipta prostrata** L. An erect or prostrate, rough annual. Heads white. Common in marshes, swamps, and riversides.
Local name : Jangli suraj-mukhi.
Flowers and Fruits : Throughout the year.

GENTIANACEAE

20. **Hoppea dichotoma** Willd. A small, glabrous annual. Flowers pale yellow. Common in marshes, swamps, and along the banks of Abna River ; often gregarious.
Flowers and Fruits : Oct.-Feb.

21. **Exacum pedunculatum** L. An erect, slender herb. Flowers pinkish violet or violet. Occurs along the banks of rivers and irrigation canals.
Flowers and Fruits : Oct.-Feb.

22. **Canscora diffusa** R.Br. A slender, elegant herb. Flowers rosy pink. Common on way to Jeswadi, in marshes and swamps along the banks of Abna and Sukta rivers.
Flowers and Fruits : Oct.-April.

23. **Enicostemma verticillatum** Engl. An erect or procumbent, glabrous herb. Flowers white. Common along the banks of Abna River as well as in shallow marshes.
Flowers and Fruits : Sept.-May.

24. **Nymphoides cristatum** O.Ktze. An aquatic, floating herb. Flowers white. Found near the margins of Abna River and its tributaries. Also grown in freshwater ponds and tanks.
Flowers : Summer and rainy seasons.

BORAGINACEAE

25. **Heliotropium strigosum** Willd. A prostrate or procumbent herb. Flowers white. Common along the banks of canals and temporary ponds.
Flowers and Fruits : During and after rains.

CONVOLVULACEAE

26. **Ipomoea aquatica** Forsk. An aquatic, trailing, amphibious herb. Flowers pale rosy. Common in ponds, canals, ditches, and muddy ground.
Local name : Kalmisag.
Flowers and Fruits : Oct.-May.

27. **Merremia emarginata** Hal. f. A prostrate, creeping herb. Flowers yellow. Common along the banks of Abna, Sukta, and Bham rivers.
Flowers and Fruits : Sept.-Nov.

SCROPHULARIACEAE

28. **Bacopa monnieri** Penn. A semi-aquatic or marshy, prostrate herb. Flowers bluish purplish or violet. Common in marshy or wet places near canals, ponds, and lakes ; often growing profusely and dominating the ground vegetation.
Flowers : Aug.-Oct. *Fruits* : Nov.-Feb.

29. **Sopubia delphinifolia** G. Don. A tall, erect herb, elegant when in full bloom. Flowers rose-coloured or light purple. Common in marshes and ditches of low-lying areas.
Flowers and Fruits : Rainy and cold seasons.

30. **Verbascum chinense** Sant. (*Verbascum coromandelianum* O.K. ; *Celsia coromandeliana* Vahl). An erect, pubescent annual. Flowers yellow. Common along the banks of Abna, Sukta, and Bham rivers.
Flowers and Fruits : Cold and summer seasons,

31. **Stemodia viscosa** Roxb. An erect, aromatic, viscid herb. Flowers violet. Common in swamps and along the banks of canals and rivers.
Flowers and Fruits : Cold and summer seasons.

32. **Veronica anagallis-aquatica** L. An erect, succulent herb. Flowers pale purple or white. Occurs in moist situations along the banks of canals and rivers.
Flowers and Fruits : Feb.-June.

33. **Sutera dissecta** Walp. A diffuse or suberect, glandular annual. Flowers white. Common along the banks of canals and ditches.
Flowers and Fruits : Cold season.

GESNERIACEAE

34. **Didymocarpus pygmaea** C.B.Cl. A small, delicate, pubescent herb. Rare ; found along the banks of Abna and Sukta rivers on wet rocks.

ACANTHACEAE

35. **Rungia repens** Nees. A spreading or procumbent herb. Flowers violet or pinkish. Common in small patches near river banks.
Flowers and Fruits : Oct.-Jan.

36. **Justicia diffusa** Willd. An erect herb. Flowers pink or pale purple. Common throughout in marshes as well as along the banks of rivers and canals.
Flowers and Fruits : Aug.-Oct.

37. **Justicia quinqueangularis** var. **peploides** C.B.Cl. A prostrate or ascending herb. Flowers rose-coloured. Common in marshes or wet places near canals, ponds, and lakes.
Flowers and Fruits : Oct.-Apr.

38. **Asteracantha longifolia** Nees. An erect, hispid, stout herb. Flowers bright blue to bluish purple. Gregarious along the banks of fresh or stagnant water ditches and swamps.
Local name : Untkatara.
Flowers and Fruits : Oct.-Feb.

39. **Hygrophila serpyllum** T. Anders. A procumbent, glabrous herb. Occurs in marshes near Shankar Ghat.
Flowers : Cold season.

VERBENACEAE

40. **Phyla nodiflora** (L.) Greene. A creeping herb. Flowers pale pink. Gregarious in marshes as well as along the banks of Abna River.
Local name : Bakanbuti.
Flowers and Fruits : April-Aug.

LABIATAE

41. **Salvia plebeia** R.Br. An erect, deep-rooted annual. Flowers bluish white. Common along the banks of Abna River and irrigation channels.
Flowers and Fruits : Winter and summer seasons.

AMARANTHACEAE

42. **Alternanthera sessilis** R.Br. A prostrate, spreading, polymorphic herb. Flowers white. Common in damp places along the borders of ponds and tanks, or grows as an aquatic in ponds and canals with shallow water.
Local name : Bhaji ; Narhi-ki-bam.
Flowers and Fruits : During and after rains.

POLYGONACEAE

43. **Polygonum plebejum** R.Br. A prostrate, diffusely-branched herb. Flowers rosy. Common in damp places along the borders of ponds, tanks, and canals.
Local name : Machechi.
Flowers and Fruits : Cold and summer seasons.

44. **Polygonum glabrum** Willd. An erect or decumbent, stout annual. Flowers pink. Found in marshes and along canal banks.
Local name : Nali.
Flowers and Fruits : Sept.-March.

45. **Polygonum hydropiper** L. A glabrous, robust herb. Flowers pink. Occurs in marshes and along canal banks.
Flowers and Fruits : Oct.-March.

46. **Polygonum barbatum** L. An erect, glabrous annual. Flowers white. Rare along the banks of rivers.
Local name : Jalbahar.
Flowers and Fruits : Aug.-May.

47. **Rumex dentatus** L. An erect, glabrous annual. Flowers green. Uncommon. Near canal banks.

Local name : Jangli palak.
Flowers and Fruits : Jan.-June.

EUPHORBIACEAE

48. **Euphorbia hypericifolia** L. An erect or decumbent herb. Common along canal banks as well as in marshes.
Flowers and Fruits : July-Oct.

49. **Phyllanthus maderaspatensis** L. A glabrous herb. Common in marshes of temporary ponds and on black cotton soil.
Local name : Hazarmani.
Flowers : Aug.-Oct.

CERATOPHYLLACEAE

50. **Ceratophyllum demersum** L. A submerged, rootless aquatic. Common in the still water of ponds, ditches, and canals.
Flowers and Fruits : After rains.

MONOCOTYLEDONES

HYDROCHARITACEAE

51. **Hydrilla verticillata** Royle. A submerged, freshwater herb. Common and abundant in still or slowly running water of ponds, ditches, and canals.
Flowers : Sept.-Nov.

52. **Vallisneria spiralis** L. A submerged, tufted, dioecious perennial. Common in the bottom of ponds, ditches, and canals.
Flowers and Fruits : Aug.-Oct.

53. **Ottelia alismoides** Pers. A succulent, flaccid herb. Flowers white. Common in tanks and slow-running waters.
Flowers : Oct.-Feb.

COMMELINACEAE

54. **Commelina benghalensis** L. A diffuse or straggling herb with dimorphic flowers. Common in marshes and along canal banks. The leaves are used as a vegetable.
Local name : Kan-kawwa.
Flowers and Fruits : June-Nov.

55. **Commelina hasskarlii** Cl. A glabrous or pubescent herb. Flowers blue. Gregarious in marshes near temporary ponds and ditches.
Local name : Gahun-kenya.
Flowers and Fruits : Sept.-Nov.

56. **Cyanotis axillaris** Schult. f. A trailing or erect herb. Flowers pale violet. Occurs along canal banks in moist situations.
Flowers and Fruits : Oct.-Dec.

ARACEAE

57. **Pistia stratiotes** L. A floating herb. Common in tanks and jheels.
Flowers : July-Nov.

LEMNACEAE

58. **Lemna paucicostata** Hegelm. Common throughout in canals, ponds, puddles, and stagnant water collected near waste places.
Local name : Chowpatti.
Flowers : After rains.

59. **Wolffia** sp. Common throughout in ponds, puddles, and stagnant water ponds and canals, either growing alone and forming a green felt or associated with *Lemna* and *Azolla*.
Flowers : After rainy season.

POTAMOGETONACEAE

60. **Potamogeton indicus** Roxb. A floating or marshy, aquatic herb. Common in Abna, Sukta, and Bham rivers.
Flowers : Cold season. *Fruits* : Hot season.

61. **Potamogeton perfoliatus** L. A stout, submerged, aquatic herb. Common near Bhim Kund, along the margins of Abna River.
Flowers : Dec.-Feb.

62. **Potamogeton crispus** L. A slender, submerged, aquatic herb. Common in shallow, temporary water ponds, and canals of Abna and Sukta rivers.
Flowers and Fruits : Cold and hot seasons.

63. **Potamogeton pectinatus** L. A filiform, grass-like, aquatic herb. Common in the canals of Abna, Sukta, and Bham rivers.
Flowers and Fruits : Cold and hot seasons.

NAIADACEAE

64. **Naias minor** All. A small, aquatic herb. Common in still, fresh water of ponds and rivers.
Flowers : Dec.-Feb.

ZANNICHELLIACEAE

65. **Zannichellia palustris** L. Common in quiet or slowly running water of Abna, Sukta, and Bham rivers, and ponds.
Flowers and Fruits : Oct.-Feb.

CYPERACEAE

66. **Cyperus alopecuroides** Rottb. An erect, stout, marshy sedge. Common along the banks of rivers and ponds.
Flowers and Fruits : Aug.-Jan.

67. **Cyperus pygmaeus** Rottb. A very tufted, prostrate or erect herb. Common in marshes and beds of Abna River.
Flowers and Fruits : Oct.-July.

68. **Cyperus iria** L. Common in marshy lands and ditches.
Flowers and Fruits : Aug.-Apr.

69. **Cyperus compressus** L. Common in marshes and along the banks of streams.
Local name : Dhongli.
Flowers and Fruits : June-Oct.

70. **Cyperus difformis** L. An erect, tufted herb. Common along the banks of Abna River.
Flowers and Fruits : After rains.

71. **Fimbristylis dichotoma** Vahl. A tufted annual. Common in marshes and along the banks of rivers. The fresh roots emit a fragrant smell.
Flowers and Fruits : Feb.-June.

72. **Fimbristylis complanata** Link. Common in marshes and swamps.
Flowers and Fruits : Oct.-Feb.

73. **Scirpus roylei** Parker (*Scirpus quinquefarius* Buch.-Ham.). An erect, tufted sedge. Common in marshes near canals and streams.
Flowers and Fruits : Sept.-Dec.

74. **Scirpus erectus** Poir. Common along the banks of Abna, Sukta, and Bham rivers, often growing on wet rocks.
Flowers and Fruits : Late winter and summer seasons.

75. **Scirpus tuberosus** Desf. in Fl. Atl. 1 : 50, 1798-1800 ; Beetle in Amer. Jour. Bot. 29 : 84, 1942. (*Scirpus maritimus* Linn., *pro parte*). This plant is listed in our floras under the name of *Scirpus maritimus* Linn. Recently Beetle (loc. cit.) has shown that true *S. maritimus* Linn. is a European plant, found occasionally in Asia, and it includes two specific entities. The correct name for the Asiatic species is, therefore, *Scirpus tuberosus* Desf. (loc. cit.). For a complete synonymy of this plant, *see* Beetle (op. cit.).

An erect, variable sedge, 30-100 cm. high, with creeping rhizomes

and woody tubers. Stems trigonous. Umbels simple or compound. Spikelets 3-8 or solitary on each ray, dark brown. Bristles present. Nuts plano-convex, polished. Common along the banks of Abna, Sukta and Bham rivers, forming dense patches in Chhoti Nadi. The sedge is amphibious as it occurs either in water or on marshy soil.
Flowers and Fruits : Oct.-July.

76. **Scleria tessellata** Willd. Common in marshes and along canals.
Flowers and Fruits : Sept.-Dec.

GRAMINEAE

77. **Saccharum spontaneum** L. Common near canals, ponds, and marshy places.
Local name : Kans.
Flowers and Fruits : Sept.-Dec.

78. **Imperata cylindrica** Beauv. Common near ponds and canals of Abna River, often becoming abundant and dominating the vegetation.
Flowers and Fruits : June-Oct.

79. **Hemarthria compressa** R.Br. A hygrophilous, perennial grass. Occurs in marshes and along the banks of Abna River.
Flowers and Fruits : June-Sept.

80. **Paspalum distichum** L. Common along the banks of Abna River and near ponds and puddles.
Flowers and Fruits : June-Sept.

81. **Paspalidium flavidum** A. Camus. Common along canal banks and ponds. A good fodder grass.
Local name : Kel-chara.
Flowers and Fruits : May-Oct.

82. **Echinochloa colonum** Link. Very common in ditches.
Local name : Saonria.
Flowers and Fruits : June-Oct.

83. **Echinochloa crus-galli** Beauv. Common along irrigation channels and margins of ponds.
Local name : Panad ghas.
Flowers and Fruits : July-Nov.

84. **Leptochloa panicea** Ohwi. A slender, annual grass. Common near canals and ponds.
Flowers and Fruits : June-Sept.

85. **Eriochloa procera** Hubb. Common near canals, ponds, and ditches.
Flowers and Fruits : Aug.-Dec.

86. **Setaria tomentosa** Kunth. Common near canals, ponds, and ditches.
Local name : Chich-larha.
Flowers and Fruits : Aug.-Oct.

87. **Cynodon dactylon** Pers. Common and abundant in marshes and swamps.
Local name : Dub.
Flowers : Throughout the year.

88. **Aristida depressa** Retz. Common near banks of Abna River, forming dense tufts in local patches.
Local name : Sukli.
Flowers and Fruits : July-Oct.

89. **Sorghum halepense** Pers. A perennial, tall grass. Found sporadically along the banks of canals. The culms are used as pens for writing purposes.
Local name : Baru.
Flowers and Fruits : Sept.-Feb.

90. **Andropogon pumilus** Roxb. A small, copper-coloured grass. Gregarious in marshes and swamps.
Flowers and Fruits : Oct.-Feb.

91. **Apluda mutica** L. A small grass with delicate culms. Occurs in moist situations near canals, ponds, and puddles.
Local name : Phulria ; Phuli.
Flowers and Fruits : Sept.-Nov.

92. **Brachiaria eruciformis** Griseb. A very weak grass. Common in marshes, and swamps.
Local name : Sirput.
Flowers and Fruits : Sept.-Nov.

93. **Coix lachryma-jobi** L. A tall, densely tufted grass. Gregarious along watercourses, irrigation channels, and ditches.
Local name : Panad ; Barru.
Flowers : Sept.-Dec. *Fruits* : Feb.-April.

94. **Dinebra retroflexa** Panz. A small, trailing grass. Common along the banks of Abna River.
Flowers : Sept.-Nov.

95. **Rottboellia exaltata** L. Common in marshes, swamps, and along the banks of rivers.
Flowers : Aug.-Nov.

96. **Ischaemum rugosum** Salisb. Common along the banks of marshes and canals.
Local name : Badawar.
Flowers : Oct.-Feb.

97. **Hygrorhiza aristata** Nees. A floating grass. Common in still or slow running water of Abna River.
Flowers : Cold and summer seasons.

ACKNOWLEDGEMENT

I am grateful to Rev. Fr. H. Santapau, S.J., F.N.I., for kindly going through the manuscript and suggesting improvements.

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Reviews

1. INSECT MIGRATION. By C. B. Williams. Pp. xiii+235 (21.5×14.5 cm.). 11 coloured plates, 22 photographs in black and white, and 49 maps and diagrams. The New Naturalist series. Collins, London, 1958. Price 30*s*. net.

In 1938 Dr. Williams wrote an article on Butterfly Migration in India (*J. Bombay nat. Hist. Soc.* **40**: 439-457) which summarised the existing records, hoping thereby to stimulate collectors' interest in the subject and to get further observations from them. His own interest was aroused much earlier, in 1916, when in British Guiana he happened upon a migration of *Phoebis statira*. Since then he has not only observed himself, but has with a few enthusiastic helpers collected a vast body of information scattered through the literature. Migration is now regarded as a much more generalised phenomenon than was previously realised. In this book Dr. Williams discusses butterfly migration in relation to those of other insects and to those of vertebrates, and gives the reader some idea of the magnitude of the problems involved.

The New Naturalist series is primarily concerned with British natural history, but to quote the dust jacket '. . . INSECT MIGRATION deals with the subject on an international basis, with Britain . . . as the natural peg on which a biological problem belonging to the whole world can be hung'.

Insect migration is more difficult to tackle by direct means than is bird migration. Several attempts have been made to mark migrating butterflies but, in every case, of thousands marked only one or two have been recovered, and those fairly close to the point of release. The only exception to this was in 1952, when Urquhart in Canada marked Monarch Butterflies (*Danaus plexippus*) and recovered 2 individuals from 450 and 480 miles to the south. Only once has the start of a migration been observed—that of the Painted Lady (*Vanessa cardui*). In 1869 Sketcherley observed vast numbers emerging from their chrysalids in the desert by the Red Sea. They dried their wings, and flew eastwards towards the sea. The production of locust swarms is better understood. It has been shown that the migratory form is produced when intense breeding leads to overcrowding of young hoppers. But even here there is ambiguity, because it has been shown that the solitary form can also migrate over some hundreds of miles.

Insects have been shown to be capable of some incredible feats—for example the tiny moth *Plutella maculipennis*, barely half an inch across, flies over the North Sea to Britain from Europe. Spectacular flights involving many thousand individuals and continuing for days on end are known in many parts of the world. Sometimes they have become part of local folklore. Our *Euploea core* migrates regularly along the coast at Ratnagiri, and the local inhabitants have come to regard it as the forerunner of the monsoon.

The problems raised are many and various. For example the question arises of how butterflies navigate. If they do so by the position of the sun, do they compensate for the shift in its position during the day? The instinct to go in a straight line is so strong that butterflies on migration will rise and fly over an obstacle rather than go round it. Wind does not affect the direction of flight—the insects shift the axes of their bodies to compensate for the drift, and continue to fly in the same direction as before. One could go on quoting from this fascinating book for a long time. All collectors should read it; they have a real opportunity to make a contribution to the subject.

R.R.

2. THE MYSTERY OF THE FLAMINGOS. By Leslie Brown. Pp. 116 (14×21.5 cm.). 23 photographic plates, 2 maps, 1 diagram. Country Life, London, 1959. 25*s*. net.

In recent years the name of Leslie Brown has become a byword for East African flamingo lore. Those who have had the privilege of seeing his magnificent colour film of African flamingos, or read his account of the breeding of the Greater Flamingo in Kenya (*Ibis*, 1958) need no introduction to his competence as a field naturalist. For several years he has dedicated himself with exemplary zeal, and one may even say exemplary foolhardiness, to the study of flamingos in order to unravel some of the puzzling problems connected with these large and spectacular birds.

The brackish soda lakes of the Great Rift Valley of East Africa—Nakuru, Hannington, Natron, Elementeita, and others—have long been known as the home of the Lesser Flamingo (*Phoeniconaias minor*) and traveller after traveller has extolled the breath-taking spectacle of its gigantic concentrations. But owing to the extremely inhospitable and difficult nature of the terrain no serious exploration or study of the birds had been undertaken until 1953 when Leslie

Brown, an officer of the Kenya Agricultural Department, appeared on the scene. While these African lakes were known to be the principal breeding grounds of the Lesser Flamingo, it was only within recent years that the Greater Flamingo (*Phoenicopterus ruber*) was also reported to breed there on a limited scale. It is to the author's credit that by an unremitting onslaught of reconnaissances by land and air he contrived to visit and acquaint himself not only with practically all the haunts and breeding places of both the African flamingos, but also to discover intimate details of their life histories which had hitherto remained hidden. That in the process he more than once nearly lost his life in unenviable circumstances, and taught himself to fly an aeroplane so that he could probe into the remotest fastnesses of the birds, are incidentals in the remarkable story which the book tells.

The discovery of large breeding colonies of the Greater Flamingo —one of about 5000 pairs—at Lake Elmenteita, on rocky islands and without the orthodox mud-cone nests, is significant for us in India. Observations in the Great Rann of Kutch had indicated that in years of drought, or when the water level and other natural conditions are inappropriate, breeding of flamingos does not take place here at all. The birds, after concentrating at the traditional site, disperse again. Since there is no other known breeding place in India, it was conjectured that the birds either skipped a lean year, or years, completely, or that they betook themselves to some alternative area outside the country for the purpose. Although there are some known breeding places nearer home (e.g. Ab-i-istadeh in Afghanistan, and in the Persian Gulf and Iraq) these are not large enough to accommodate the enormous rebound from the Rann of Kutch. The Camargue and southern Spain had been postulated, but they seemed too distant for a last-minute makeshift. The hypothesis of alternative breeding grounds now derives some support from the discovery of these large nesting colonies on the East African lakes, and our birds may well migrate there to breed at times when conditions in the Rann are unfavourable. However, this is all mere speculation which can only be tested by a large scale marking of the birds on their breeding grounds in a manner that would enable their recognition at a distance, without the necessity of recapture. In spite of the swarms of non-flying young available in the more populous nesting colonies, those with any experience will admit that marking the chicks is a less simple affair than it would appear!

The detailed observations on the ecology and various life phases of the flamingos—some original, others amplifications of what was imperfectly known before—are important contributions to scientific ornithology in general, and to flamingo lore in particular. They cover every aspect of the birds' life-history—food, feeding habits, breeding cycle including courtship and mating behaviour, and others. The observations are doubly valuable for the comparisons they afford between the Lesser and the Greater Flamingo, so similar in outward appearance and general habitat, yet each with its own special food and feeding habits and morphological adaptations which permit such vast numbers of both to subsist side by side without competing for the food supply.

In his previous books, BIRDS AND I (1946) and EAGLES (1955) Brown had given ample proof of being a first class field ornithologist and an expert bird photographer. The present volume sustains and enhances that reputation. The photographs of both the Greater and the Lesser Flamingo are without doubt the finest the reviewer has seen, and are truly admirable in their purposefulness as illustrations besides. This is a book that no bird lover should miss.

S.A.

3. THE ARK IN OUR MIDST. The Story of the Introduced Animals of Britain: Birds, Beasts, Reptiles, Amphibians, Fishes. By R. S. R. Fitter. Pp. 320 (20×13 cm.). 18 plates (16 of photographs and 2 of drawings). Collins, London, 1959. Price 18*s*.

Ten years of research have gone into the preparation of THE ARK IN OUR MIDST, the first book which covers all known attempts to introduce new animals into Britain and to extend the range of indigenous species. In 1860 Frank Buckland brought together a group of enthusiasts under the grandiose title of 'The Society for the Acclimatisation of Animals, Birds, Fishes, Insects and Vegetables within the United Kingdom'. But introductions were being made long before this. These were mainly by sporting land-owners who restocked their estates with foreign deer, game birds, and game fishes. However, there have been many attempts made simply to enrich the local fauna with attractive alien species—the American robin (*Turdus migratorius*), and the green tree-frog (*Hyla arborea*) for example. Most attempts have ended in failure, and it is not difficult to see why. Climate, lack of suitable breeding places, competition from established species, predators, all combine against an introduced species. Considerable perseverance is sometimes needed before success is achieved. For instance, Waterton decided in 1841 that the

Little Owl (*Athene noctua*) would be useful as a destroyer of snails and other vermin. Accordingly, he bought a dozen in Rome. Of these five survived shipwreck and other hazards to reach England, but they did not establish themselves. In 1876 there was another unsuccessful attempt by Lord Kimberley. Over the next ten years or so, many Little Owls were released in various places, and by the end of the century they were breeding in four counties, and by 1950 had begun to spread to Scotland.

Little Owls encountered much prejudice as suspected game-chick killers, although they were shown to feed mainly on insects, mice, and small song-birds. All introductions have not been so innocuous, however. Ironically enough, great pains were taken to introduce the rabbit (*Oryctolagus cuniculus*) into Scotland, where it rapidly became a pest. Some of the most successful aliens have been accidental introductions. The house mouse (*Mus musculus*) originated in southern Russia, and seems to have followed the spread of agricultural civilisation. It reached Britain by the route Iran-Iraq-Syria-Palestine-N. Africa-Mediterranean, and probably arrived in a shipload of grain, or in a traveller's baggage. More recently another harmful alien, the musk rat (*Ondatra zibethica*) escaped from fur farms and rapidly established itself. Fortunately prompt action by the authorities resulted in extermination.

To facilitate the recognition of the fascinating strangers whose fortunes are described by Mr. Fitter, one could wish for more illustrations like those of deer and pheasants in the two plates of drawings.

R.R.

4. SOME COMMON SNAKES AND LIZARDS OF AUSTRALIA.

By David R. McPhee. Pp. 125 (13×10 cm.). 51 illustrations. Brisbane, 1959. Jacaranda Press. Price 12*s*. 6*d*.

This little booklet deals with 25 each of the lizards and snakes of Australia. Some of the genera in both the groups are common to India, but the lizards including the Knobtailed and Leaftailed Geckos, the Bearded and Frilled Lizards with large frills round the neck, and the famous Agamid (*Moloch horridus*) with large and grotesque spines scattered all over the head and upper parts appear to be more curious and varied than those found with us. Each form is illustrated by a photograph and, while all of them are not very satisfactory, the accompanying text is in most cases sufficient to permit a layman to identify the animal.

A general note on lizards and snakes precedes each section, but it is nowhere stated how many kinds of snakes or lizards are known in Australia. It would be useful to inform and warn beginners that this is not a complete list and that many more kinds may be encountered.

As in India, many curious beliefs and fallacies exist regarding reptiles. The author states (p. 68) that it is anatomically impossible for a snake to suck milk from a cow but, in recent correspondence, a retired officer of the Indian Forest Service claims to have personally seen it done. Again, American scientists are said to have experimentally revealed (p. 66) that a fast moving snake at top speed does not exceed 3½ miles per hour. The author believes that some Australian snakes can travel faster, and we have no doubt that a man would have to trot, if not run, to keep up with a fast travelling Indian dhaman on level ground.

This kind of book is badly needed in India. Very little is known about the lives and habits of the 300 kinds of lizards and the almost equal number of snakes found in India, and the gaps in our knowledge can only be filled by more people giving the subject their attention. Once a person is familiar with even the more common species he will notice differences among the others and will enquire more closely and intelligently into their identity and habits whenever an opportunity arises.

H.A.

5. BUMBLEBEES. By John B. Free and Colin G. Butler. Pp. 208 (21×14 cm.). 1 colour illustration, 24 plates in black and white, and 3 figures. The New Naturalist series. Collins, London, 1959. Price 25*s*.

The value of honeybees as plant pollinators is well known. It is less generally known that bumblebees are sometimes more effective pollinators. The pollinating value of a single bumblebee is equal to that of several honeybees, since bumblebees not only work faster, but for longer, and in worse weather. Self-sterile species of plants are more likely to be pollinated by bumblebees because of their habit of visiting only a few flowers on one plant before flying on to the next. One such self-sterile plant, Red Clover, is of considerable economic importance. It was because of their value in pollinating the Red Clover crop that bumblebees were introduced into Australia and New Zealand, where they are not indigenous.

Bumblebees live in colonies whose social organisation is halfway between the solitary bees and the highly evolved honeybee colonies. Bumblebee colonies are annual, at least in the temperate zone. The old queen, workers, and males die off at the approach of winter, and only young mated queens survive to form new colonies in the spring. Very little is known about what happens to bumblebee colonies in the tropics. Observations made in Mexico seem to indicate that colony growth can take place all through the year, although brood production is greatly reduced during the dry season. Unlike the queen honeybee, who is little more than an egg-laying machine, the queen bumblebee is physically similar to her workers apart from being larger, and she carries out many tasks throughout her life, such as building eggcells, incubating and feeding brood, as well as laying eggs.

Bumblebees do not seem to have developed any form of communication to compare with the elaborate dance language of honeybees. When a bumblebee out foraging discovers a rich source of nectar she may return to it again and again, but she does not bring back companions. A great deal is known about what attracts individual bees to flowers. Kugler demonstrated that sight was more important than scent when a bumblebee is flying towards a flower. He did this by covering a plant with a tall glass cylinder, open at the top. Approaching bees flew not to the top of the cylinder, where they could smell the flowers, but to the middle, where they could see them. However scent is important, since bees can be trained to models having a particular scent. Bumblebees sometimes also recognise the general form of a plant. Bees working Houndstongue, which has small inconspicuous flowers, will sometimes fly to a plant having no flowers. On the other hand bees visiting Foxgloves, whose flowers are large and conspicuous, do not fly to flowerless plants. Apparently they have learnt to react to the flowers and not to the form of the plant.

Another respect in which bumblebees and honeybees differ is in their mating behaviour. Male bumblebees fly from their nests when between two and four days old and do not return. In some species they hover round the entrances of nests of their own species and pounce on young queens as they emerge. The males of other species establish routes for themselves which they scent-mark every day, and fly round them waiting for young queens to cross their paths. One male was observed to complete his circuit seventy-seven times in a day.

The monograph ends with two appendices by Ian H. H. Yarrow.

One is an introduction to the collection and maintenance of bumblebee colonies. The other is a simplified key to the identification of British bumblebees. All books of this kind should include information of this type if they are intended to act as intellectual apéritifs rather than nightcaps.

R.R.

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Miscellaneous Notes

1. IN DEFENCE OF THE TIGER

A few days ago I read in one of the daily newspapers that in the Damini forests of Chhattisgarh region 'three tigers were bagged in five minutes'. This may be considered a remarkable and even a commendable feat by some, but I feel constrained to write a few words in defence of this grand animal whose disappearance from our forests will be a sad thing for our country—and disappear he will unless public opinion comes to his rescue.

The tiger has been an unfortunate victim of persecution for many years, particularly so since the advent of the powerful modern cordite rifle, the jeep, and the spot-light. In his natural dominion—the undisturbed forests away from human habitation—he is not a dangerous animal, and he causes much less harm or damage to man and his property than is generally supposed. It is only when man destroys his local and natural food supply, the wild pig and the various kinds of deer, that the 'Lord of the Jungle' is forced to quit his normal habitat and habits and takes to killing domestic cattle which graze near and sometimes in the outer fringe of the jungle. Much more rarely, after being wounded by man or for some other specific reason, he may become first a mankiller and then a maneater—but this is extremely rare when counted against the many tigers living a normal and natural life deep inside the jungle.

In the incident mentioned above three tigers met their death one after the other in a beat at the hands of a 'shikari'. One of the three animals was mentioned as having been 8 ft. 8 in. in length. Since the measurements of the other two were not given, I presume that they were smaller. The average size of a full-grown male tiger is between 9 ft. and 9 ft. 6 in., and the tigress is about a foot smaller. These lengths would be from the tip of the nose to the tip of the tail as measured 'between pegs', as against the more common and less definite way of measuring 'round the curves' which gives results a few inches more than the 'between pegs' measurement. My second guess, therefore, in respect of the incident under reference is that the animal measuring 8 ft. 8 in. was a tigress.

Unlike the lion, the male tiger, except in the mating season, does not remain with the tigress or the cubs. As a matter of fact as soon as the cubs are born the tigress will resent the presence of their father, and the latter also is then no longer interested in his family. It follows, therefore, that outside the mating season, whenever two or more tigers are seen together they are usually, if not invariably, a tigress and her cubs. The cubs remain with their mother for as long as they are not able to fend for themselves, this period of dependence lasts till they are about two years old. My third guess about the episode is that the other two tigers killed were cubs of under two years of age.

The tigress does not produce a litter every year as is commonly supposed. Because the cubs remain with her for about two years, she has her babies usually every third year, for as long as she is young enough to have them. I am speaking of tigers in the jungle and not of zoo tigers where owing to artificial conditions the natural routine is upset. The cubs require about five years to attain full maturity and size, the first two years of which are spent under the care and protection of their mother. A two-year-old tiger in respect of behaviour and appetite would be much like a boy of twelve or thirteen. I remember when I was of that age I was almost perpetually hungry. I would say that the 'teens period of a tiger's life is when he is between two and four years old. A hungry tiger is much more hungry than a hungry boy, and therefore during this period it is difficult for a tigress to provide enough food for herself as well as for her ever-hungry children. As soon as the cubs are capable of making independent kills and fending for themselves they separate from their mother and from each other, or if they are lazy and not exerting themselves enough, after a period of maternal patience and spoon-feeding, they are chased away by the exasperated mother. Now, the point of all this is that if cubs are found with their mother they are probably under two years old. At this age they are so entirely dependent on their mother that, if she is killed, they would not desert her immediately. In their bewilderment and confusion they will remain in the vicinity of their dead mother and get killed themselves, if the 'shikari' shows no compassion. I feel this is what happened in the incident under reference.

To say nothing of killing immature cubs, I would say that one should, as far as possible, abstain from killing the female of any species—including the tiger. This is not for any medieval notions of 'chivalry' about the female sex, but because that is the most effective way of exterminating a species.

What goes to the credit of a big game hunter is not the mere number of tigers or any other animals that he has bagged in his career as a sportsman, in one year, in one trip, or 'in five minutes';

what matters is the discrimination and the sense of fair play which he shows in selecting what he shoots—and more important than that, the manner in which he shoots his big game.

I have said above that the normal jungle-dwelling tiger does no harm to man in any way but helps to maintain the balance of life in the jungle. He kills only when he is hungry because it was the will of God that he shall live in this manner. When tigers take to the slaughter of domestic animals, and even to the quite unnatural diet of human flesh, the fault almost invariably lies with man in one way or another—and in rare exceptions is due to some accident or sheer old age resulting in the tiger's inability to procure his natural food.

Not so long ago I had the memorable experience of watching for a long time a tigress and her few-months-old cub feeding on a dead bullock. Particularly amusing and delightful to watch were the antics of the young cub who had a bigger appetite than his mother but not her ability and strength for tearing off chunks of meat from the carcass. Unlike the unfortunate three which were killed in five minutes, these two are still alive, I hope, somewhere on the borders of Bhutan, adding to the wealth and charm of those beautiful jungles.

I can do no better than repeat the words of Jim Corbett, that great hunter and lover of wild animals: 'A tiger is a large-hearted gentleman with boundless courage and when he is exterminated—as exterminated he will be unless public opinion rallies to his support—India will be the poorer by having lost the finest of her fauna.'

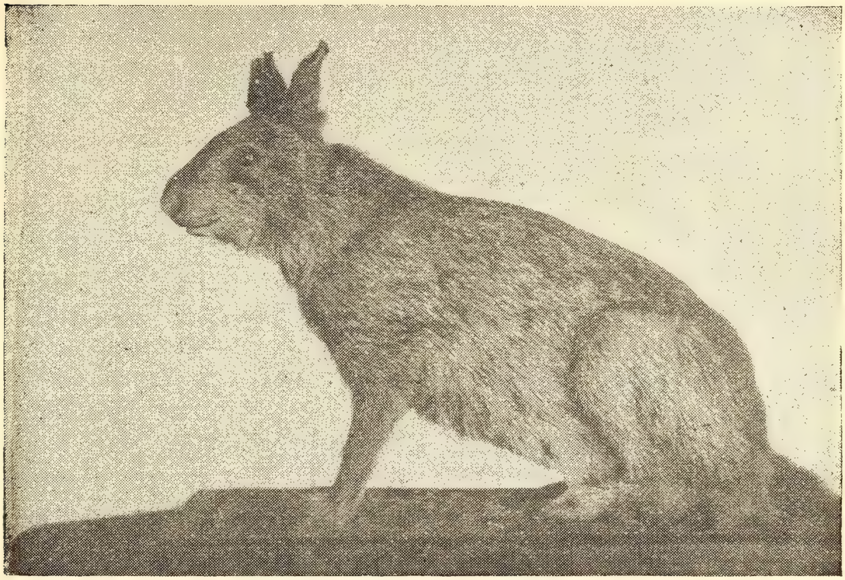
1, J. & K. MILITIA,
c/o 56, A.P.O.,
April 10, 1960.

M. M. ISMAIL,
Lt.-Col.

2. THE HISPID HARE, *CAPROLAGUS HISPIDUS* (PEARSON)

(*With a photo*)

Jerdon, Sterndale, and Blanford all refer to the occurrence of the Hispid Hare (*Caprolagus hispidus*) in the terai from Gorakhpur to Assam extending south to Dacca. It weighed about 5½ lb. and Hodgson was informed by the Mechis that its food consisted chiefly of roots and bark of trees. E. B. Baker (1887) in SPORT IN BENGAL said that it was 'unfit for the table and not worth shooting except as a curiosity; nor does it give the greyhounds the chance of a course, sticking as it does to thick coverts'.



Hispid Hare, *Caprolagus hispidus*

Jerdon said that it frequented jungly places along coarse bamboos etc., shunning observation, and that its flesh was white like a rabbit's. Sterndale added that it burrowed like a rabbit, but according to Hodgson was not gregarious, living in pairs. He did not know if the young were born blind and naked.

Simson (1886) in LETTERS ON SPORT IN EASTERN BENGAL referred to the skin tearing very easily and his failure therefore to preserve a single skin.

Though we have specimens in our collection obtained by J. C. H. Mitchell in Assam, date unknown, and from north Kheri, U.P., by L. D. W. Hearsey on 16-3-1926 and C. H. Stockley on 30-1-1930, this animal was not obtained by the Bombay Natural History Society's Mammal Survey and it is generally held in the same category of rareness as the Pigmy Hog and the Pinkheaded Duck. Inglis, Travers, O'Donel and Shebbeare in 'A Tentative List of the Vertebrates of Jalpaiguri District, Bengal' (*J. Bombay nat. Hist. Soc.* **26**: 825) said it was 'not so common as formerly owing to the decrease in grass jungle in the district'. It may therefore be interesting to note that in the course of recent correspondence Dinesh Pratap Singh, Raja of Kasmanda, mentions that his late father shot one in 1938 in the North Kheri Forest Division on the Kheri, U.P.-Nepal border. Another was shot in March 1951 in Bellrien Forest range in North Kheri Forest Division near the Bela Parsua Rest House when beating through grass bordering a small lake with a line of elephants. A photograph of the first animal mounted by Van Ingen & Van Ingen is reproduced. It must be mentioned, however, that Pearson's original description said that 'the ears were short not projecting beyond the fur' and it is therefore not quite certain how closely the photograph resembles the live animal.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
July 14, 1960.

EDITORS

3 'TUSKS OF INDIAN ELEPHANTS'

With reference to my letter of April 4, 1956 (*J. Bombay nat. Hist. Soc.* **53**: 690-1) on the subject of big tusks, I have since heard from the Raja of Talcher. The measurements of his tusks (No. 2), shown by me in the statement of big tusks, should stand corrected as follows:

No.	Length outside curve	Greatest circumference	Weight
2	8′ 11″ R	20″	1 md. 19 sr. = 120 lb.
	(8′ 6″)		(92 lb.)
	8′ 9″ L		1 md. 16 sr. = 114 lb.
	(8′ 6″)	19″	(92 lb.)

The weights of the large Assam pair (No. 1) should be shown as 101 lb. each (91 lb. 13 ch.).

Thus, the record for *girth* and *weight* goes to the Raja of Talcher, while the record for *length* goes to the Assam pair.

New Forest P. O.,
Dehra Dun,
May 14, 1960.

P. D. STRACEY

[The figures earlier recorded are menioned in parentheses.—Eds.]

4. WILD LIFE IN SOME AREAS OF SOUTH INDIA

Humayun Abdulali's rather depressing accounts of wild life in Madhya Pradesh have prompted me to submit a short note on what I have seen of game in areas near the Nilgiri and Biligirirangan hills in Madras State in two recent visits to India, in January and February 1958, and at the same time in 1960.

I had not been in India between 1931 and 1958, and in my boyhood I had little knowledge of the game in these areas other than the fact that I used often to see sambar when walking about on the downs near Ootacamund, and I once saw a tiger in a shola five miles from Ooty. In both 1958 and 1960 I was given the most depressing account of the status of game animals in both these areas by people who should have known. I was told that game had been decimated since Independence, largely by the efforts of poachers armed with guns, licensed ostensibly for crop protection but in practice used for shooting without authority in reserved forests. In 1958 game was stated to exist but in much reduced numbers, while in 1960 I was informed that the Bandipur jungles, once so famous, had been shot out although they were supposed to be a sanctuary. The general consensus of opinion in both years was that 'the sambar and chital won't last long'.

In 1958 I spent a week in the jungles round Mavanhulla in the Nilgiri area, and another ten days in the Biligiris. At Mavanhulla I saw every possible species of game animal I could see except a tiger, and the basic stock of game appeared to be satisfactory; not a day passed without seeing a minimum of fifty chital and ten sambar, with other species such as gaur and jungle sheep[1] in smaller numbers. Five bears, a panther, and a wild elephant completed the list. There was a tiger in the area, which I disturbed, but did not see as he left the thicket in which I had located him literally on my heels. I was told by one of the officers there that the adjacent Mudumallai wild life sanctuary contained at least 1000 chital, 300 gaur, and twenty tigers, and at the time this seemed quite possible in view of the numbers of game actually seen in a much smaller area near by. In the Biligiris there was much less game to be seen than in the Mavanhulla area, but there appeared to be a fair head of gaur and sambar, while we located the haunts of at least three separate tigers. It may only have been a travesty of former abundance, but the game was certainly not eliminated. In the Nilgiris, on the high plateau sambar were few, but I saw without difficulty a herd of 16 Nilgiri Tahr.

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[1] The Barking Deer, *Muntiacus muntjak* (Zimmermann) is commonly known by this name in southern India.—Eds.

In 1960 I made actual counts of the game I saw and related these to the ecology of the area and to the total area which I could claim to have covered. The latter was estimated by noting the number of miles walked and the mean visibility on both sides, so that the sample covered a strip of country; where larger areas were overlooked from the top of a hill area was reckoned from a 1-inch survey map and added in. The results are presented in the table below:

Area	Chital	Sambar	Gaur	Jungle sheep	Area sampled in sq. miles	Density per sq. mile
Mavanhulla ..	105	22	10	1	5.2	26
N. Coimbatore ..	14	5	2	11	6.5	4.8

The Mavanhulla area is largely fairly open *Anogeissus-Heteropogon* grass woodland with thickets of *Lantana* and *Acacia* in gullies, bamboo on river banks, and a good deal of *Zizyphus* on the fruits of which bears were feeding. Since I kept out of the thicker cover it is certain that I did not see all the game there was, and the figure for density of large herbivores per square mile should probably be rather higher. There were in addition at least five hundred head of buffaloes and cattle grazing in the area. The game stock appeared to be about the same as, or slightly higher than, in 1958, and is certainly very satisfactory. At any rate I can think of no area in Africa with so many human beings in it which would carry anything like this stock of game. The carrying capacity of the area was probably inherently higher than in similar savannah in Africa because of relatively abundant and well-distributed water supplies; no animal would have had to go more than two miles to get water and most not more than one mile. Taking the domestic animals into account, and equating the smaller herbivores at three chital per stock unit, the total stocking works out at about one stock unit per 4½ acres—which I should judge as near the maximum that such country could hold without danger of overgrazing (which was occurring in some areas near cattle sheds).

On the evidence of tracks, there were at least two tigers in this small area, one an old male, the other also a male but young. The old male had the reputation of killing domestic stock and not returning to his kills. There were also reports of panthers, droppings of bears, one of which I saw, and an odd elephant.

The North Coimbatore area comprised parts of the Satyamangalam and Tallamalai forest ranges, the former closed to shooting but apparently carrying no more game than the latter. The whole area was said to be 'poached out'. The country was hilly, chiefly covered with *Anogeissus-Cymbopogon* grass woodland, with denser forest and bamboo in river valleys, and here and there, on poorly drained soils, close-cropped maidans studded with *Zizyphus* trees. Although the cover was thicker and the actual bulk of herbage greater per unit area than in Mavanhulla, the great majority of the grass was *Cymbopogon,* a species most unpalatable except when very young after a burn. It was not anything like such a good game habitat naturally as the Mavanhulla area, but nevertheless I formed the conclusion that it ought to have carried more than it did since there were areas of palatable grass quite untouched. I saw not a single mature stag of either sambar or chital in the area, and there were no young calves in the small herds of chital I saw. There were a good many elephants in the area but only one was seen. Again there were probably more game animals than I actually saw owing to the dense cover and the prevalence of patches of forest. There were also herds of cattle and buffaloes, which were probably aggravating the fire problem in these forests by eating down the palatable grasses and so permitting the increasing dominance of the *Cymbopogon,* thus creating a splendid medium for fierce and destructive grass fires.

I saw one tiger in this area. I watched it walk along a path at about ten in the morning from the top of a hill, and had it in view for a quarter of an hour. It behaved precisely like a dog on a round of lamp-posts, sniffing the boles of trees carefully, and sometimes urinating with its tail curled over its back. It was a large male and appeared very well nourished. The range officer, Tallamallai, told me that tigers were not shot by local shikaris, but that poachers made serious inroads into the deer population; this agreed with my own observations.

These figures were of course only collected over a short period, and the game may migrate from place to place in both the areas concerned. Possibly I met an unusual concentration at Mavanhulla, and it certainly appeared that more gaur would be found in the North Coimbatore areas at other times of the year (there were old tracks of larger herds). However, I believe that the figures given represent something like the relative carrying capacity of the two areas; a noteworthy feature is the abundance of barking deer in *Cymbopogon* grassland.

Elsewhere in South India I saw few game animals, despite walking about a good deal in potentially good game country. On Anaimudi, the highest peak of the High Range I saw twenty tahr in 3 herds, and in passing I would say that it seems strange that this animal, which does not appear to be confined to cliffs or even rocky country, is not very much more numerous than it is. On the Palni Hills, for instance, there appears to be a very large area of habitat suitable for it, but I saw none.

In the Mavanhulla area the first suggestion that was made to me by a shikari that I engaged was that I should go out and shoot a tiger in the lights of my car. The Nilgiri Game Association's report remarks, however, that night shooting from cars is on the decrease in the areas they control. Certainly there is no evidence of wholesale butchery and I did not hear a shot while I was there. The Association is to be congratulated on the head of game it has managed to maintain, at least in the areas I visited.

On the wider question of wild life preservation in India generally, it appears that there are 109 million acres[1] of reserved forest in India, and a further 255 million acres not available for cultivation. Some of the latter will be roads, tanks, villages, and small patches of waste land, but it must also include large areas of hillsides not at present reserved, and which are unsuitable for cultivation. Supposing that a proportion of this area could become game habitat, it seems possible that there might be 200 million acres of possible game ground, which at even the Tallamallai density would support over 1,500,000 large herbivores, and at 10 to the square mile over 3 million. Data must exist, or could be gathered which would enable an assessment of the total potential game population on an ecological basis to be made, which could serve as a target figure to be achieved in any future conservation programme.

A basic stock of game seems to exist even in areas which are said to be very heavily poached—shot out in fact by local account; in fact these areas are less denuded of game than many areas of Africa where game was abundant some 20 years ago. The position is similar to that reached in the United States where through uncontrolled hunting the game animals reached a very low ebb. Severe restrictions on hunting built up the stocks again until in several states there are now too many deer for the range to carry in winter, and the problem is to get enough shot each year. At any rate it is inescapable arithmetic that the potential game stock of India will stand only a certain kill each year, and that the existing stock will stand only a far smaller kill at present. If restrictions are not placed on shooting at present there will be no game for future generations to shoot.

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[1] 1 acre = 0.41 hectares.

India has at least one priceless advantage, that there is a religious objection to killing on the part of a large proportion of the people. If either of the areas I visited were inhabited by African tribes I would wager there would not by now be a single game animal left alive. With this in favour I would agree with Humayun Abdulali that there should be no reason why India's game stock should not be built up again and to do so would be in accordance with sound forest management. One appreciates that the control of poaching with guns supposed to be for the protection of crops is a difficult problem, but at least India does not have the poisoned arrow to contend with, carried by every able-bodied male among hundreds of thousands all over Africa. The right of a peasant to protect his crops against marauding game must be admitted, but there is no reason why he should not be required to keep his gun permanently on his farm or person. This nettle will have to be grasped if the remaining stock of India's game is to be preserved and built up again, and the shikari who hunts for sport will have to be restricted to the potential kill in any area.

The tourist who visits India may wish to see the Taj Mahal, or he may wish to shoot a tiger; in either case he will have paid several hundred pounds to reach India before he begins, and will be inclined to take the attitude that he is certainly entitled to get what he came for. The unscrupulous will undoubtedly kill their tiger in the light of a tractor's headlight if given the chance, but experience in Kenya is that sportsmen from overseas are prepared to submit to restrictions on what they may kill if they can see that these restrictions are imposed in the interests of preserving a stock of game for future generations. If, on the other hand, he pays for a licence and other expenses and hears unlicensed guns banging off all round he may be expected to feel resentful, and determine to get his tiger by hook or by crook. Licences should probably be for individual animals, on a ticket system, returnable if the animal is not shot. I myself have been glad to pay the small licence fees required for hunting in the

Nilgiri area and elsewhere in the knowledge that I have thereby been contributing in the only way possible towards the survival of Indian wild life.

KAREN,
KENYA COLONY, LESLIE BROWN
April 27, 1960.

5. THE EASTERN CALANDRA LARK (*MELANOCORYPHA BIMACULATA*) IN KUTCH

On 5 February 1960 I went to Bada (near Mandvi) and on the mudflats there I saw several flocks of larks which looked distinctly larger and quite different from the Short-toed Lark (*Calandrella brachydactyla*) which come in large numbers to Kutch in winter. On closer inspection with the help of field glasses I was certain that I had once again come across a bird which had not yet been recorded in Kutch. After this a specimen was shot by M. K. Shivbhadrasinhji of Bhavnagar, who was with me that day, and on closer examination later I found that it was the Eastern Calandra Lark (*Melanocorypha bimaculata*). This lark is said to spend the winter months in the Punjab, U. P., Rajasthan, Sind, etc., and therefore it is likely to stray into Kutch also, but somehow it seems to have escaped the notice of bird watchers.

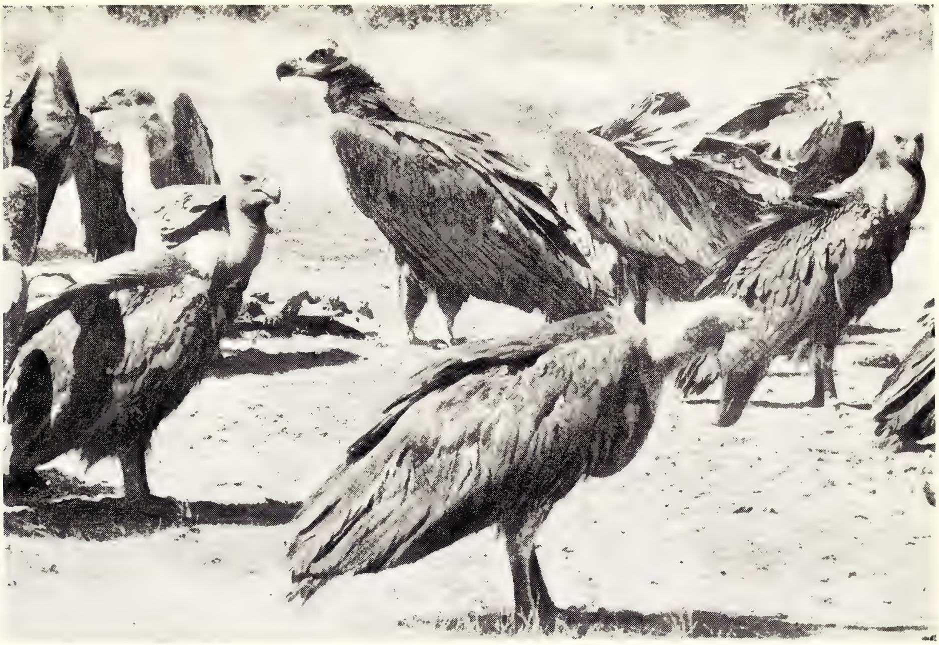
BHUJ,
KUTCH, M. K. HIMMATSINHJI
March 31, 1960.

[The specimen was sent to the Society and its identification as *M. bimaculata* has been confirmed. The condition was not good enough for racial discrimination, but it presumably belonged to *torquata* Blyth, the breeding population of Baluchistan.—EDS.]

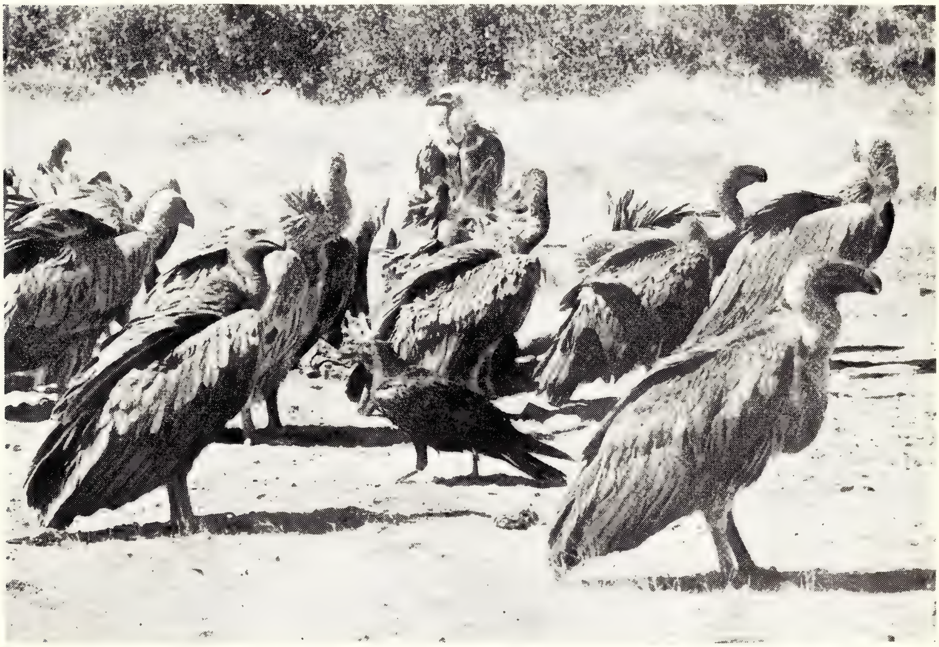
6. THE CINEREOUS VULTURE [*AEGYPIUS MONACHUS* (LINNAEUS)]—AN ADDITION TO THE BIRDS OF KUTCH

(*With a plate*)

On 9 March 1960, while motoring through the Banni, I observed a solitary Cinereous Vulture (*Aegypius monachus*) among a gathering of other vultures.



A Cinereous Vulture (*Aegypius monachus*) among Indian Griffon(?) and Whitebacked Vultures



Another rare visitor to Kutch. A raven (*Corvus corax laurencei*) among vultures at a carcase

Photos : Charles Ho

Subsequently, on 19 March 1960 while photographing vultures at an animal carcase on Kuar Bet off Pachham, Mr. Charles Ho obtained an excellent picture of a solitary Cinereous Vulture amongst a gathering of Whitebacked and Longbilled (possibly also some Fulvous) Vultures and a pair of ravens (*Corvus corax*). Mr. Ho remarked on the enormous size and dark coloration of this bird, and on the deference shown to it by the other feasters. The raven in the bottom picture, according to Mr. Ho, was definitely not the brown-necked species, therefore doubtless *C. c. laurencei* which has been collected in Kutch before.

33, Pali Hill,
Bandra,
Bombay 50,
April 25, 1960.

SÁLIM ALI

[This large vulture is found in south Europe, northern Africa, and eastwards through south-west and south-central Asia to India and China. It breeds in Baluchistan and possibly along the Himalayas to Cachar in Assam. In winter it descends into the Punjab, Sind, and other parts of northern India, the southernmost record being from Mitli in Kaira District, about 40 miles south of Ahmedabad (*J. Bombay nat. Hist. Soc.* **50**: 945-6).—Eds.]

7. ON THE OCCURRENCE OF THE REDHEADED MERLIN (*FALCO CHIQUERA*) IN KERALA

Though in popular bird books there are vague general remarks implying that the Redheaded Merlin (*Falco chiquera*) might be met with all over south India, Whistler (1936) questions the occurrence of the species in the then Presidency of Madras. He states: 'Dewar includes the Redheaded Merlin in his Madras list, but as he makes no comment on the fact and there is no other record for the Presidency, I think it wiser not to admit the species to the Presidency list until further evidence is forthcoming.'

Koelz (1947) records a male taken at Cudappah on March 20. This appears to be the only definite record for the south.

The facts given below show that the bird not only occurs in Kerala State, but might even be found breeding here.

I saw the Redheaded Merlin first at Kavasseri (Palghat Dist.). On 4 June 1950, late in the evening two Merlins came flying from the jungle across a river, and alighted on a palmyra tree. Their incessant bickering and the fact that finally one was chased away by the other suggested that they were not a mated pair. I made no attempt to judge their sexes, but noted that (i) only one of them had a prominent moustachial streak, (ii) it had also a more reddish head than the other, and (iii) only one of the birds uttered call-notes: a continual *tiririririri-tiririririri*. In the light of later experience, I guess that the one which uttered the call-notes was a fully-fledged young bird which the other, presumably a parent, was trying to shake off.

A single, silent Redheaded Merlin was found at the same spot on 18 May 1951, again in the evening.

On 30 April 1958, I took up residence at Chittur-Cochin, 15 miles ENE. of Kavasseri. On 22 May 1958, I found three Redheaded Merlins on a palmyra tree beside the river in terrain almost identical with that where the birds were seen at Kavasseri. Time 18.30 hrs.

At 11.00 hrs. on the next day they were not found at the place, but at 13.30 hrs. all three were there. Judging by the absence of barring on the breast and the middle of the underparts as well as by their constant calling and wing-quivering when perched, I decided that two were young ones. The other bird of the party had breast and the rest of the underparts closely barred in grey, and was constantly chivvying kites and Serpent Eagles which passed that way. It was undoubtedly a parent bird.

That evening I watched them again from 17.00 hrs. for half an hour. One of the juveniles had disappeared. The two that were there repeatedly swooped at Common Mynas feeding on the meadow between the trees and the river, but the mynas just scattered and none was caught.

Once the two falcons pursued a Whitebreasted Kingfisher. The kingfisher fell flop into the shallow stream in the river. Every time it attempted to escape, the falcons swooped forcing the kingfisher back into the water. After half-a-dozen tries at the victim, the falcons moved off and the kingfisher escaped.

On the 24th at 18.15 hrs. there were only two falcons at the place. None was found at 18.30 hrs. on the 25th. On the 28th at 17.00 hrs. there were two. On the 30th only one at 17.30 hrs. On the 4th of June at 18.30 hrs. one was present.

Having decided to obtain a skin for confirmation of my identification, I went to their haunts on 8 June with a friend who had agreed to shoot one of the birds for me. At 18.00 hrs. a single falcon came flying with a small bird in its talons and, alighting on a palmyra frond, began feeding. My friend shot the bird just as it had finished eating. The skin was sent to the Bombay Natural History Society, and Dr. Sálim Ali confirmed my identification. Sri Humayun Abdulali wrote: 'From the size and colour the specimen appears to be a female in immature plumage'.

The Redheaded Merlin was seen again in the same area later on. Details are given below:

11th June 1958—One seen flying over at 11·00 hrs.
13th ,, ,, — ,, ,, ,, ,, ,, 18·40 hrs.
12th April 1959—Two harrying a Brahminy Kite at 18·30 hrs.
13th ,, ,, —One ,, ,, ,, ,, 18·15 hrs.
14th ,, ,, —One eating a small bird on palmyra tree, 18·00 hrs.

My thanks are due to Sri M. Srinathan Nair, Cochin Nair Bank, Chittur, for having shot one of the falcons for me, and to Sri M. K. Prasad, then Lecturer in Botany, Govt. College, Chittur, for having prepared the skin.

GOVERNMENT COLLEGE,
CHITTUR-COCHIN,
April 15, 1960.

K. K. NEELAKANTAN

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Whistler, H. (1936): The Vernay Scientific Survey of the Eastern Ghats. *J. Bombay nat. Hist. Soc.* **38**: 419.

[The Virus Research Centre at Poona have in their collection a male and a female *Falco chiquera* obtained by B. S. Lamba at Palivada in Krishna District, Andhra State on 17th November 1956.—EDS.]

8. THE BUFFBREASTED SANDPIPER, *TRYNGITES SUBRUFICOLLIS* (VIEILLOT): AN ADDITION TO THE AVIFAUNA OF INDIA AND CEYLON

A specimen collected by Dr. T. S. U. De Zylva on 5 March 1960 at Kalametiya Lagoon was forwarded to me for identification. My identification has been confirmed by the Senior Scientific Officer in the Bird Room at the British Museum (Natural History), London. Sex, unfortunately, unknown.

Kalametiya Lagoon, situated on the southern coast of Ceylon, is bordered by a grass plain on the eastern side which is cropped low by cattle and buffalo. Dr. De Zylva states the bird was seen by itself on this grass plain reminding him of a Golden Plover; on making a closer inspection through binoculars he realised it to be something new and out of the ordinary. This is the first record of this species from Ceylon, which adds a new bird to the list of our avifauna.

The HANDBOOK OF BRITISH BIRDS gives its distribution as:

'N.W. Nearctic region—breeds on arctic coasts of N. America from N. Alaska to N. Mackenzie. (No proof of breeding in E. Asia) Migrates through N. and Central America to S. America (Argentina and Uruguay; noted on migration N. E. Siberia). Casual in Japan, W. Indies, Bermuda, and accidental in France, Switzerland, Heligoland, Red Sea, and possibly Turkey.

Nineteen specimens have been recorded from the British Isles, mostly in September, but one in May, one July, one August, one October.'

It has no subspecies. It can be distinguished by pink-buff under parts and by the inner webs of the primaries and secondaries being freckled with black, and short, slender, black bill; the head is noticeably rounded.

Dr. De Zylva is to be congratulated on his keen observation thus making this most interesting find possible.

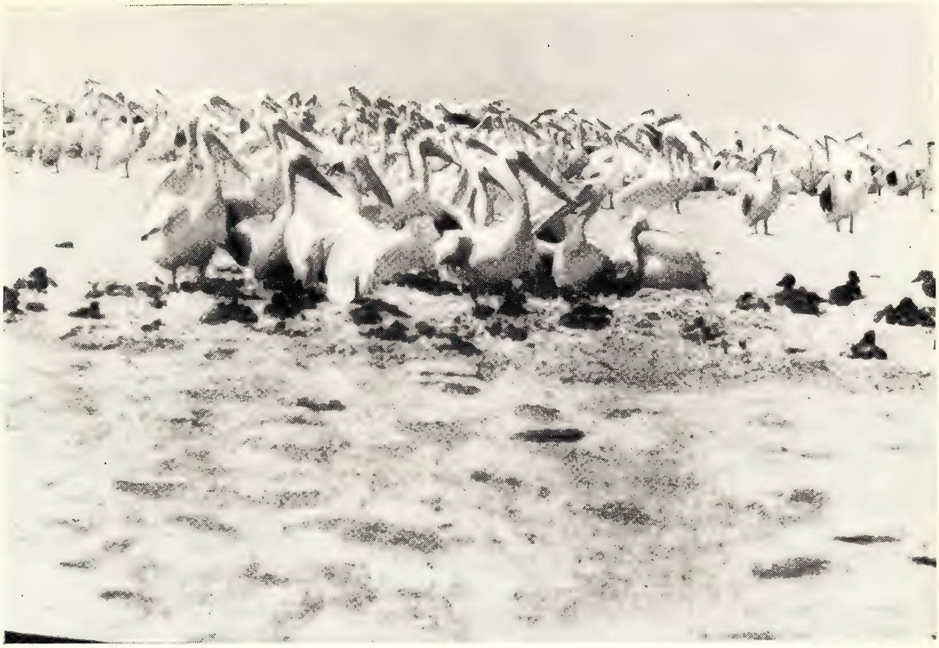
PINGARAWA,
NAMUNUKULA,
CEYLON,
April 14, 1960.

C. E. NORRIS,
F.Z.S., M.B.O.U.

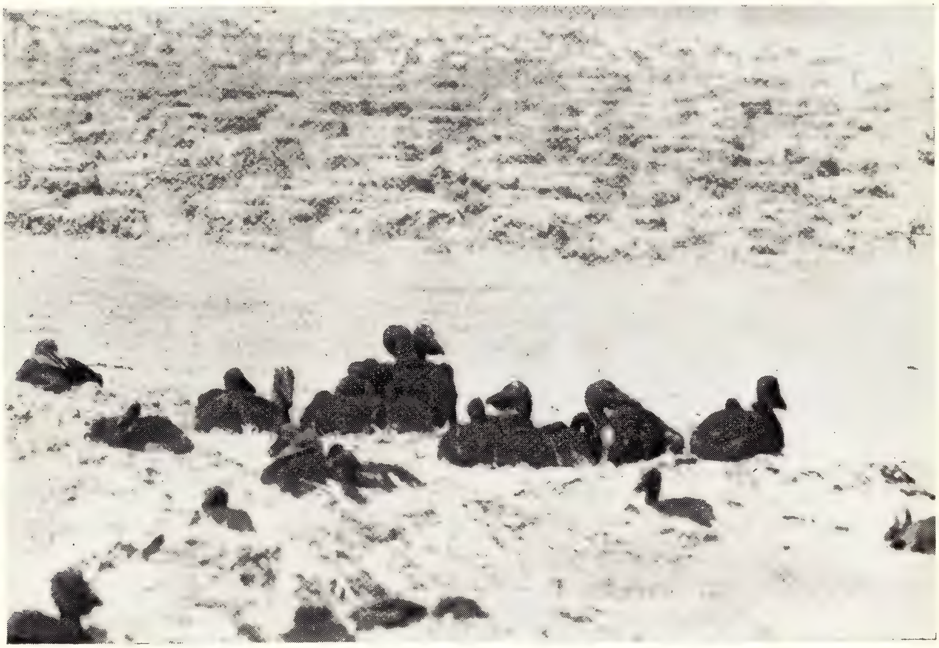
9. 'FLAMINGO CITY' RE-VISITED: NESTING OF THE ROSY PELICAN (*PELECANUS ONOCROTALUS* LINNAEUS) IN THE RANN OF KUTCH[1]

(*With a plate*)

Owing to the abnormally heavy rainfall in Kutch during the SW. monsoon of 1959 (in some areas over 60" against the annual average of about 15") the Great Rann was inordinately flooded in March 1960. The marginal area along the base of the rocky range of hills running E.-W., known as Kala Dongar, over which it is possible in normal years to go by jeep from Kotda to Nir was still partially submerged by 20 March, or too wet and treacherous even for jeep traffic. Therefore, in order to reach Nir, the base for Flamingo City, it was necessary to travel camelback from Kakrao Police Outpost near Kuran village—a distance of about 14 miles (3 hours)—over rough stony ground cross-country along the lower contours of Kala Dongar. During more or less the entire camel journey the edge of the Rann



Rosy Pelican (*Pelecanus onocrotalus*), adults and chicks, in pelicanry in the Rann of Kutch



Rosy Pelican (*Pelecanus onocrotalus*) chicks in pelicanry in the Rann of Kutch with flamingos in the background

Photos : Sálim Ali

remained in sight, and from time to time there could be seen in the shallow brine jostling masses, looking like flat mud islets, of thousands of mixed waders—Common and Dusky Redshanks (*Tringa totanus* and *T. fuscus*), Ruff & Reeve (*Philomachus pugnax*), Dunlins (*Calidris alpinus*), stints (*Calidris temminckii* and *C. minutus*), sandpipers (*Tringa nebularia, T. stagnatilis, T. ochropus, T. glareola, T. hypoleucos*), Stilts (*Himantopus himantopus*), Little Ring Plovers (*Charadrius dubius*), and perhaps also others too far off to identify, but certainly with a sprinkling of Turnstones (*Arenaria interpres*) amongst them. At Nir there was also a considerable concourse of White Storks (*Ciconia ciconia*)—one flock of 300-400—a species I had not met with in such large numbers in Kutch before, and about 50 spoonbills (*Platalea leucorodia*). There were also present large numbers of a species of gull which, owing to the distance, could not be satisfactorily identified. In size they were between the Blackheaded and the Herring Gull—silvery grey above, white below with darkish shading to underside of the wing near the tip (primaries) rather as in the blackheaded species. There was no black visible in the head while the bill and legs appeared to be black without any glint of red even in good light. With them there were the similarly coloured but unmistakable Gullbilled Terns (*Gelochelidon nilotica*).

On the morning of 21 March accompanied by Charles Ho, we started on camels for Flamingo City about 8 miles NE. of Nir under the guidance of the erstwhile Flamingo Warden, Jamal Nathoo. The entire intervening distance was now one vast expanse of water from ankle to knee deep, stretching on three sides to the featureless horizon. With the perilous swaying and slithering of the camels on the treacherous bottom mud, the ride was scarcely conducive to physical comfort or mental relaxation, and one had the curious feeling of suddenly being transported from the ship of the desert to a ship on the ocean! A heavy cross-wind whipped up the surface into angry little wavelets and, in the absence of any landmarks to steer by, all this gave the disturbing illusion of our animals being constantly drifted away from a straight course. Under these conditions it took us a full 4 hours to reach Flamingo City.

The 'City' itself was situated in its traditional site, now an extensive pancake-flat sun-baked mud island only a few inches above the level of the surrounding water. The area actually occupied by the nest mounds has expanded considerably since my last visit in 1957, and its broadest and most thickly populated part now stretches for quite half or three-quarters of a mile. The number of flamingos here was greater than I have ever known before. The impression, which I noted down on the spot, was that there were at least twice as many birds as estimated by me in April 1945, therefore (including adults and juveniles) something of the order of a million individuals. However, owing to pressure of time no sample counts were possible as on the previous occasion, and this guess possibly means little more than that there was indeed a truly fantastic concentration of birds. The nesting was now at its peak and in all stages, from birds sitting on more or less fresh eggs, through new hatchlings, grey downy runners of two or three progressive age groups, to even a few lanky flying youngsters in the brown juvenile plumage.

A new and unprecedented feature was the presence within and for several miles around Flamingo City of vast numbers of Eastern White or Rosy Pelicans (*Pelecanus onocrotalus*)—Kutchchi *Pēn*—dotted about in herds or rafts of varying sizes, estimated as aggregating 3000-4000 birds. Several hundred pairs of these were nesting in certain sections along the periphery of the occupied flamingo colony, in what may be called its deserted suburbs, among the bases of old worn-down stumps of the nest mounds. The nests consisted of from a skimpy to a fairly substantial bed of large white feathers (the birds' own and flamingos'). They were close together, roughly one to a square yard, and contained mostly 2 eggs or young each, but in some cases 3 and occasionally 4. The eggs were ivory white with a smooth gloss and not chalky-textured like flamingo eggs, though of about the same size, only broader. Twenty-five eggs averaged 95.56×61.65 mm. Maximum 103×63 and 102×66.5 mm.; minimum 87×60 mm. and 95×57 mm.

14 eggs from the Persian Gulf (F.B.I., ii ed. **6**: 273, averaged 88.3×57.5 mm. Maximum 94.1×60.0 mm.; minimum 83.1×58.0 mm. and 89.0×55.0 mm.

Unlike the tree-nesting Spottedbilled Pelican whose nestlings are covered with snow-white down, the nestlings of the Rann pelicans wore a funereal livery of dull sooty black. When newly hatched the young is naked, rather glossy skinned dark flesh-coloured. In the slightly older chicks (at 3 or 4 days?) the skin turns blackish, and the chick becomes blacker when the feather papillae begin to show and the down and quills sprout. The bill, bill-pouch, and legs are all funereal black. The larger squabs are enormously fat and ugly; when approached they tend to herd together and waddle away with an unsteady, ungainly gait. Little dumps of cast-up fish, each of astonishing quantity, soon lay dotted about the nests as the young disgorged them in fright on our approach. Some of these fish were fully 10″ long and must have easily weighed ½ lb.

This is the first record of the Rosy Pelican breeding within Indian limits where it has hitherto been considered a winter visitor only. As far as I am aware its nearest known breeding place is, or was, Bubyan Island at the head of the Persian Gulf where La Personne, collecting for Sir Percy Cox, found a colony in 1922 (*J. Bombay nat. Hist. Soc.* **31**: 109). But it is curious that although this colony contained downy chicks at the time no mention of their colour is made. Likewise there is no description of the downy young in any of the better known literature I have consulted in spite of the fact that it is so startlingly different from its parents and from similar chicks of the Spottedbilled species.

The discovery of the Rosy Pelican breeding in the Great Rann of Kutch again points up to the many surprises that await a proper biological exploration of this unique and truly fantastic salt desert. It will be remembered that my visit to Flamingo City in 1945 produced the first record of an avocet breeding colony on Indian soil. Although agitated avocets were present in small numbers in March this year also, and probably breeding, no definite evidence of this was procured.

33, PALI HILL,
BANDRA,
BOMBAY 50,
April 15, 1960.

SÁLIM ALI

10. IN SEARCH OF THE PINKHEADED DUCK [*RHODONESSA CARYOPHYLLACEA* (LATHAM)]

I have just returned from a tour of north Bihar where I had gone in search of the Pinkheaded Duck. Having failed to locate the 'Patraha Katla'[1] anywhere in the Bhagalpur district in spite of extensive enquiries, and finding a place called Pathraha shown on the 1″ topographical map of Purnea district, I made my way to Forbesganj in the extreme north of the district. Pathraha, which lies some seven miles west of Forbesganj and is approachable only by bullock cart, proved disappointing. All the chaurs and jheels have been reclaimed for cultivation, and I could not find a single habitat which even remotely resembled that of the Pinkheaded Duck.

Mr. Frank B. Simson mentions in *Ibis*, 1884, p. 271 the area in the south of the Purnea district lying between the Kosi and Ganga rivers as a favoured locality for this bird. He particularly mentions the Purnea Trunk Road, and a travellers' bungalow on it. The map showed the area lying between Karhagola Road railway station and the Ganga River as full of jheels and chaurs. Karhagola Road lies on the Purnea Trunk Road, and there is a travellers' bungalow there. Unfortunately the bulk of this area too has been reclaimed for cultivation, and Mr. Simson's description of 'pools of deep water abounding in wild fowl and crocodiles' reads like an after-dinner story. I found only two chaurs, the Chapri and the Drona, each nearly 10-12 acres in extent, lying past Uchla village, some 1½ miles south of Karhagola Road railway station. The Drona chaur was practically devoid of vegetation, but the Chapri chaur had water hyacinth, lotuses, and dry grass. Both are located in the midst of cultivated fields, and neither looked in the least suitable as a place for the Pinkheaded Duck. Though I could not find the duck, I found some interesting water birds. Of particular interest was a colony of River Terns breeding, and there were 9 young ones playing or flying on the banks of the Drona chaur. They appeared to be in almost exclusive occupation of the chaur. I have not seen such a big colony even on the river Ganga. The other interesting bird was the Spurwinged Plover, which probably breeds there.

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[1] Where an anonymous writer in the defunct *Asian Sporting Newspaper* had found it breeding in July 1880.

I showed the pictures given in the *Illustrated Weekly of India* (28th July 1957) with Mr. Sálim Ali's article to a number of villagers, and they all unhesitatingly pointed out the Redcrested Pochard or *lal sir* as visiting the chaurs in large numbers with other ducks during the cold weather. They also told me that both these chaurs were extensively shot over during the winter, and only some 15 days before my visit a party had bagged about 20. They proved more accurate observers than a 'sportsman', who told me that 'these migratory birds go back to their nesting places by the end of March' on being questioned about the Pinkheaded Duck, and was obviously referring to the Redcrested Pochard. Nawab Chaudhri Nazirul Hassan, a great shikari of north Bihar, however, mentioned that he had shot a pair of Pinkheaded ducks with Mr. Atkins many, many years ago, but had not seen any since then. One more locality in Darbhanga will be investigated by me next cold weather, since the last record of this duck is from this area in June, 1935.

4, EUROPEAN BACHELORS' QUARTERS,
DORANDA, P.O. HINOO,
RANCHI,
April 29, 1960.

JAMAL ARA

[We are informed by Mr. D. E. Reuben, I.C.S. (Retd.) that a pair shot by Nawab Chaudhri Nazirul Hassan and T. Atkins at Bakhtiarpur (Monghyr Dist.) on 11 March 1924 are exhibited in the Patna Museum.—Eds.]

11. A PINKHEADED DUCK [*RHODONESSA CARYOPHYLLACEA* (LATHAM)] AT LAST?

This is to inform you that, on 28 and 29 February 1960, I along with a friend Shri Grehawal, an Engineer in the Western Command, Simla, saw a solitary Pinkheaded Duck in a local tank in 'Kunihar State' situated about 40 miles south of Simla.

We tried to take a coloured photograph but, owing to the abundance of reeds and lack of a proper hide, we were unsuccessful in taking the picture. My Wildlife Guard told us that this drake was in the tank for the last two months or so along with Mallard and Common Teal.

Simla 4, K. L. MEHTA,
March 23, 1960. *Deputy Game Warden, Himachal Pradesh*

[It will be recalled that the last *definite* record of this species in a wild state goes back to 1935 when a trapped bird was brought to the late Mr. C. M. Inglis, in the Darbhanga Dist., Bihar.—Eds.]

12. BIRD NETTING AND THE WEATHER: SOME EXPERIENCES IN KUTCH, MARCH 1960

Clouds loomed ominously in the Kuar Bet sky as the first net was being installed. This was only a foretaste of the unpredictable spell of weather that confronted the Migration Study Team during the three weeks of the project. There were three dust-storms, one rainfall, and on three successive nights the thermometer recorded 40°, 42°, and 52° F. respectively.

How and to what extent did this abnormal weather affect the flow of migration? The answer is difficult, but a look at the collection statistics vis-á-vis the weather-chart is suggestive.

Below, the daily collection of three migratory species, namely Lesser Whitethroat (*Sylvia curruca blythi*), Orphean Warbler (*Sylvia hortensis*), and Rosy Pastor (*Pastor roseus*) are plotted on a graph with dates on the other axis. Readings of temperature (maximum and minimum) and relative humidity are also plotted likewise.

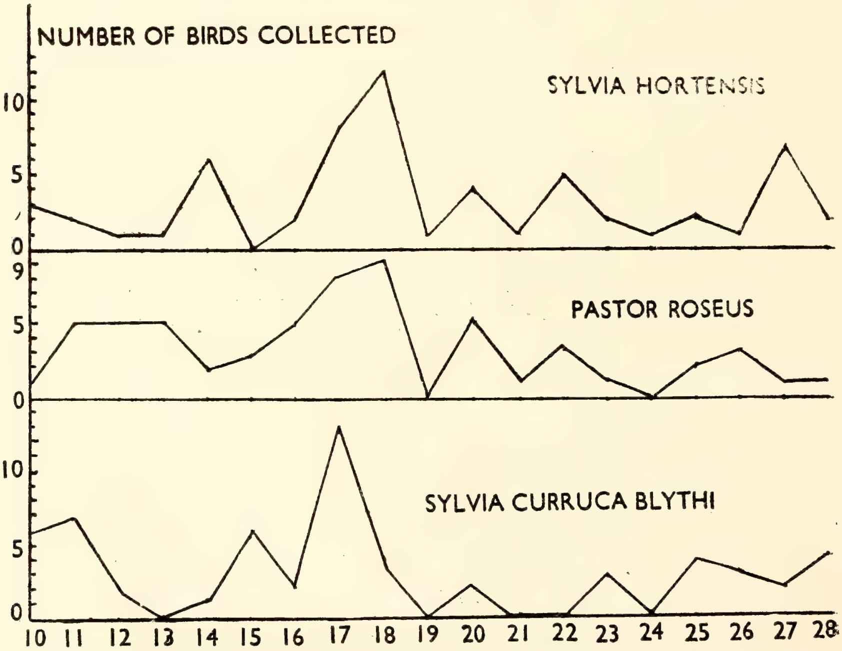
The collection period can be divided into two parts based on weather conditions:

1. *From the* 10*th to the* 18*th of March.* During this period the bird curves are on the ascendant. The Whitethroat curve reaches a peak on the 17th (13 birds). A day later the maximum numbers of Rosy Pastors and Orphean Warblers are trapped (9 and 12 respectively). The average temperature readings for this period are maximum 88.8 and minimum 66.6 Fahrenheit. The average relative humidity reads 64.5%. The minimum temperature is never below 60° F.

Two days stand out for record collection. They are: (1) 17-3-60 Max. 80°, Min. 68°, R.H. 64.5%. Number of birds collected 109. (2) 18-3-60 Max. 87°, Min. 66°, R.H. 49%. Number of birds 106.

During these 9 days 42 Whitethroats (70% of total collection of this species), 35 Orphean Warblers (57.3%) and 43 Rosy Pastors (71.4%) are recorded. This period also accounts for 69% of the total collection made during the entire project.

2. *From the* 19*th to the* 28*th of March.* The first day shows a marked fall in collection (21 birds) due to high winds that had sprung up in the night. There are temporary revivals on 20th and 22nd, after which the bird curves decline again following freakish weather.



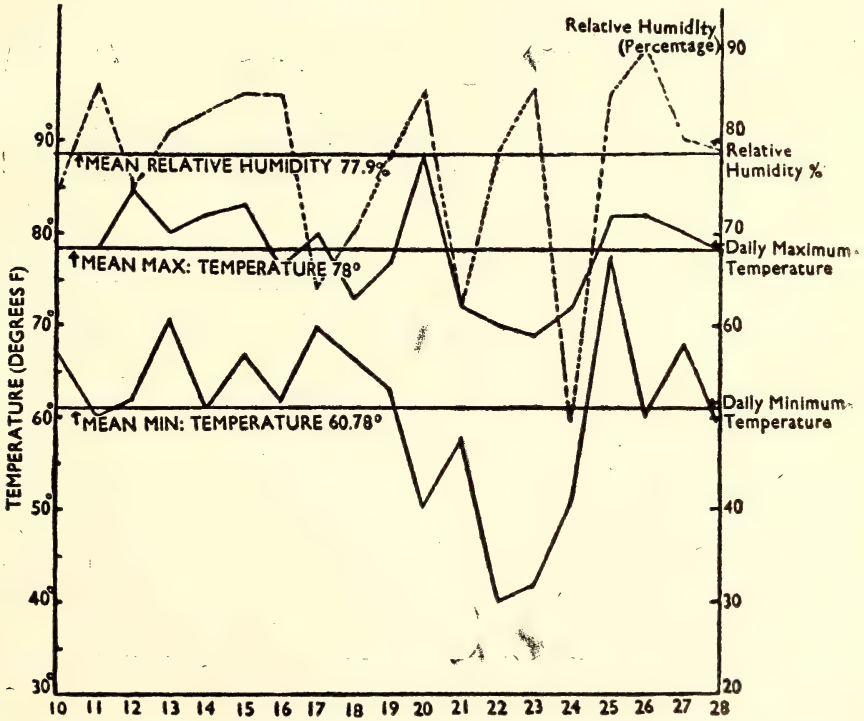
Graph showing the collection of three migratory species, Orphean Warbler, Rosy Pastor, and Lesser Whitethroat, at Kuar Bet, Kutch, 10-28 March 1960.

The weather chart shows big fluctuations from average readings during this period. The record shows:

Date	Max. Temp.	Min. Temp.	R.H.%	No. of birds collected
19.3.1960	77	63	79	21
20.3.1960	88	50	86	55
21.3.1960	72	58	63	18
22.3.1960	70	40	79	60
23.3.1960	69	42	86	39

The only exception is the capture of 7 Orphean Warblers on the 27th. In the course of these 10 days 18 Whitethroats, 26 Orphean Warblers, and 17 Rosy Pastors are recorded.

Another significant factor in the capture of birds was the flowering of *Capparis aphylla.* In the first half of the spring migration project these richly coloured and nectar-laden flowers were in full bloom, presenting a sure attraction for migrant species like Rosy Pastor and many of the warblers. Nets were erected between adjacent bushes—very often two nets were placed at an angle—so that the birds got entangled while crossing from one bush to another. This plan



Graph showing the record of air temperature at Kuar Bet, Kutch, 10 to 28 March 1960.

fetched handsome results when the flowers were in full bloom (10th to 19th of March). But once they started withering (from the 19th onward) the number of birds caught in these nets began to fall steeply.

Recapture of Banded Birds

Out of a total of three hundred and twenty migrant birds ringed in the course of the present migration study 31 were recaptured on Kuar Bet between 10-3-60 and 28-3-60.

A Bluethroat (*Erithacus svecica*), banded on the 15th of March, was recaptured on the 28th. This is the longest period of stay of a migrant bird on the present record and suggests that the bird had probably overwintered here and was not on the move. Similarly, a Thickbilled Warbler (*Phragamaticola aëdon*), banded on 10-3-60, and the only one of its kind to be ringed, was caught again on the 22nd.

The following are particulars of some of the other migrants recaptured:

Ring No.	Name of Bird	Date of ringing	Date of recapture
A1652	*Acrocephalus stentoreus*	11.3.60	23.3.60
A1826	*Acrocephalus stentoreus*	15.3.60	18.3.60
A1838	*Acrocephalus stentoreus*	15.3.60	18.3.60
A1810	*Acrocephalus dumetorum*	15.3.60	22.3.60
A1808	*Acrocephalus dumetorum*	15.3.60	20.3.60
A1815	*Acrocephalus dumetorum*	15.3.60	16.3.60
A1763	*Sylvia hortensis*	13.3.60	23.3.60
A1981	*Sylvia hortensis*	17.3.60	25.3.60
A1657	*Sylvia curruca blythi*	11.3.60	19.3.60
A1901	*Sylvia curruca blythi*	16.3.60	25.3.60
A1619	*Sylvia curruca blythi*	10.3.60	15.3.60
A1929	*Sylvia curruca blythi*	17.3.60	18.3.60
A1934	*Sylvia curruca blythi*	17.3.60	18.3.60
A2153	*Hippolais caligata rama*	22.3.60	28.3.60
A1664	*Hippolais caligata rama*	11.3.60	12.3.60
B 599	*Pastor roseus*	13.3.60	15.3.60
A1902	*Phoenicurus ochruros*	16.3.60	27.3.60
A1977	*Phoenicurus ochruros*	17.3.60	20.3.60
A1958	*Phoenicurus ochruros*	17.3.60	18.3.60
A1841	*Erithacus svecica*	15.3.60	28.3.60
A1706	*Erithacus svecica*	12.3.60	15.3.60
A1770	*Muscicapa parva*	14.3.60	23.3.60
A1833	*Muscicapa parva*	15.3.60	18.3.60
AB190	*Upupa epops*	18.3.60	26.3.60
A1724	*Jynx torquilla*	13.3.60	20.3.60
A1753	*Jynx torquilla*	13.3.60	19.3.60
AB194	*Jynx torquilla*	18.3.60	22.3.60
A1799	*Jynx torquilla*	14.3.60	16.3.60
AB044	*Jynx torquilla*	11.3.60	12.3.60

A House Sparrow, ringed on Kuar Bet on the 18th, was recaptured on the 25th at Vad vāli vai near Kotda. This involved a straight line distance of about four miles across a bare arm of the Rann, suggesting that the birds fly such long distances to forage.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
April 15, 1960.

DANIEL MATHEW

13. NOTES ON THE SPINYTAILED LIZARD, *UROMASTIX HARDWICKI* GRAY

In the latter half of February 1959 I had the opportunity of visiting the Banni on the borders of the Rann of Kutch. The 'Sanda' or Spinytailed Lizard (*Uromastix hardwicki* Gray) was common and there were large colonies on the outskirts of villages. The Banni is flooded during the rains and the villagers and the lizards form colonies on islands where alone they can survive.

They appeared to be very watchful and as our jeep approached would scuttle away into their holes, often 20 to 30 yards away. Their movements were too fast even to make an attempt at catching them by placing one's feet on their holes as is said to be done by boys in the Salt Ranges (Hora, *Rec. Ind. Mus.* **25**: 369-376).

At Dhorda we stopped for lunch and met a local inhabitant who offered to secure some. We went out to shoot spotted sandgrouse and when we came back after two hours, he had a bag full of lizards. When placed on the ground, however, they refused to run and a closer examination showed that they all had their backbones broken just behind the neck; we were informed that they would live for over a week and require no attention! These were put into spirit and we went out again to catch some more.

In the heat of the afternoon most of them had entered their holes but the method of their capture was very simple. The hunter was armed with two hard sticks, one about three-quarters inch diameter and four feet long and the other a little thicker, half its length, and pointed at one end. Having examined the entrance from which he could tell if the animal was within or not, he would quickly push in the longer stick as far as it would go, wedging the lizard against the wall. Then squatting near the hole and holding the big stick down with his toes, he used the shorter stick, as a pick-axe holding it between both his hands. Between 12 inches and 18 inches he would reach the tunnel and then grab the animal with his bare hands. It was quite harmless and never made the slightest attempt at biting, though it would thrash sideways with its tail, the spines on which were quite formidable.

Differences in colour were noticed in the field and the villager said that it was possible to tell the males by their longer tails. Though I could not then check upon the difference, I have subsequently sexed and measured the specimens with the assistance of Mr. V. K. Chari of the Prince of Wales Museum with the following results:

Sex	*Total length*	*Head & body*	*Tail*	*Percentage of tail to head & body*
♀	392 mm.	224 mm.	168 mm.	75
♀	396 mm.	226 mm.	170 mm.	75.3
♀	370 mm.	220 mm.	150 mm.	68
♂	403 mm.	225 mm.	178 mm.	79
♂	..	248 mm.	125 mm. (damaged)	..
♂	369 mm.	196 mm.	173 mm.	88
♂	489 mm.	269 mm.	220 mm.	81.7
♂	415 mm.	223 mm.	192 mm.	86
? (alive)	340 mm.	200 mm.	140 mm.	70 (♀?)
? (alive)	441 mm.	240 mm.	201 mm.	83 (♂?)

It will be noticed that in the females the tails range from 68-75% of the length of the head and body while in the males they are 79-88%, i.e. appreciably longer. After preservation in formalin the males were darker in colour than the females, which also appeared to have paler spots on the chin. These differences were, however, not visible on the two live specimens which from the proportions of their tails (83% and 70%) appeared to be of different sexes.

The tails of 1 male (79%) and 2 females (69 & 70%) from Thar & Parkar and Lahore in the Society's collections are within these limits.

What the villager told me and the conclusion pointed at by the above-mentioned measurements are confirmed by E. Home Purves (*J. Bombay nat. Hist. Soc.* **23**: 780-784) in his notes on this species in the Punjab. He refers to 'certain low class Indians who eat this lizard and hunt it systematically', and observes that they can distinguish beween the male and female by the length, shape, and size of the tail and in no case were they found to err. No details however are mentioned of these differences.

The proportionate shortness of the tails of female lizards and snakes does not appear to have been often referred to in Indian literature, but is apparently in agreement with facts observed elsewhere and it may be worthwhile checking for our many and varied forms. Oliver, in THE NATURAL HISTORY OF NORTH AMERICAN AMPHIBIANS AND REPTILES: 277, says: 'In reptiles, males frequently have relatively longer tails than females, but this is usually not under hormonal control, for at birth males already have proportionately longer tails'.

The two live specimens had the iris reddish orange. The females all had 12-20 eggs in each ovary, the largest about 5 mm. in diameter. The males showed enlarged testes varying between 17×12 mm. and 24×14 mm., all after shrinkage in formalin. Yellow fat bodies were present near the gonads in all of both sexes. The species is diurnal and herbivorous and the stomachs held remains of vegetation, mostly grasses.

Smith (FAUNA, p. 245) indicates an average size of 305 mm. for this species and refers to their attaining a total length of 350 mm. He also refers to a 450 mm. individual from Karachi as unusually large. The male from Thar & Parkar which had enlarged testes measured 388 mm. and the two females 296 and 238 mm. In the present series, the males averaged 415 mm. (369-489 mm.) and the females 375 mm. (340-396 mm.).

All the specimens captured were measured and it is significant that no small ones were obtained. Is the Kutch population larger in size?

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
October 16, 1959.

HUMAYUN ABDULALI

[The Society's bird migration camp on Kuar Bet on the borders of the Rann in March 1960 was partly under a large Acacia tree which held a nest of a Tawny Eagle, *Aquila rapax*, containing an almost fully fledged young one. The nest was littered with the remains of tails and backbones of the Spiny-tailed Lizard, *Uromastix hardwicki*, which appeared to be the staple food at least of the young. A pair brought in by P. W. Soman, Junior Research Assistant, were cast as exhibits for the Natural History Section of the Prince of Wales Museum, Bombay. The male with a total length of 333 mm. had his tail 80% of the head and the body and the female (292 mm.) 70%.—EDS.]

14. THE BULL FROG (*RANA TIGRINA*) AS A PREDATOR OF POULTRY

During our annual family gathering for Christmas in Pithapuram (East Godavary District, Andhra Pradesh) this year, we were not served with fowl as frequently as in previous years. On enquiry my mother explained that most of the chicks reared during the year were lost and it must be the work of kites or thieves.

My two daughters and I decided that the thief must be caught. Our prize Rhode Island Red hen, with her brood of 15 chicks hardly 10 days old, was going about briskly with the chicks running hither and thither. We hid near a small bush in our compound and waited for the thief. An hour passed by but there was no sign either of kite or thief. The chicks were evidently thirsty and so was their mother. They proceeded towards a small forsaken pool in the compound. While we watched from the bush, presto, a chick disappeared and then, equally suddenly, another. We ran towards the pool and the sight was really ghastly. Two bull frogs (*Rana tigrina*) had each a chick in its mouth firmly grasped with their forelegs. Within the twinkling of an eye the victims were swallowed. At last the thief had been caught.

RESEARCH DIVISION OF ENTOMOLOGY,
AGRICULTURAL COLLEGE,
BAPATLA,
May 2, 1960.

EDWIN DHARMARAJU

15. FOUR NEW BUTTERFLIES FROM ASSAM

(*With five text-figures*)

LYCAENIDAE

1. **Spalgis baiongus** sp. nov. This species is described from a male and a female taken by Norman in thick forest in the plains of Sibsagar District. The ♀ was taken on 4 July 1954 in the Nambar Reserve and the ♂ on 5 April 1956 near the old Mokukchang road. Mr. G. E. Tite of the Tring staff of the British Museum (Natural History) has recently found a further two specimens in the Museum collection, a ♂ collected by Tytler at Ghaspani in the Naga Hills and a ♂ collected by Ferrar on Great Nicobar. Unfortunately the identity of the latter specimen cannot be determined with certainty since it lacks an abdomen.

DESCRIPTION

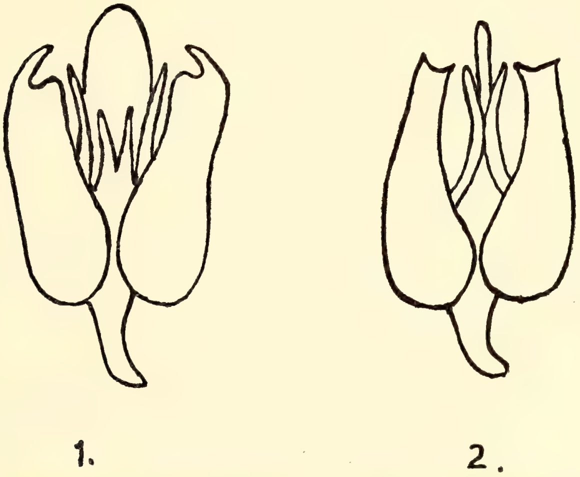
♂ and ♀. Antennae and palpi resemble those of *Spalgis epeus* Westwood.

Upper side : Both wings uniform brown with no trace of white at the end of the cell.

Under side : Both wings have rows of slender curved brown strigae similar to but much more irregular than those of *epeus.*

The strigae are outwardly lined with whitish ; inwardly each shades into a brown area, thus giving the effect of a spot and making the wing look blotched and glazed. The submarginal area of both wings is diffusely whitish (particularly the upper half of the termen of the fore wing), and as the basal area is also pale the central darker area stands out in contrast. Both in detail and in general appearance the under side is quite distinct from that of *epeus epeus* Westwood, *epeus nubilus* Moore, and *epeus titius* Frühstorfer, whose ground colour is either clear grey or clear brown. Length of fore wing from base to apex : ♂ 7 mm., ♀ 9 mm. The apex of the fore wing is much less pointed than that of *epeus.*

Genitalia : Norman dissected his ♂ in Assam, showing that the clasp differed in important respects from that of *epeus.* Unfortunately this dissection was subsequently lost, but two drawings made by Norman in 1956 correspond exactly with the genitalia of Tytler's Ghaspani specimen, which Tite very kindly dissected. The figure shows the aedeagus (but not the uncus) and the clasps of *baiongus* and *epeus.* Considerable difficulty was experienced with the morphology of the various processes until Mr. J. V. Pearman, a colleague of Tite, succeeded in the difficult task of separating the central process of *epeus* into two halves, thus proving that it is two styles and is not an annellus, although wrapped round the aedeagus. *Baiongus* has, therefore, styles as well as an annellus, while *epeus* has styles but no annellus. The aedeagus and the shape of the distal portion of the clasp also differ in the two species.



1. *S. baiongus:* aedeagus and clasps ; 2. *S. epeus:* aedeagus and clasps.

Of the specimens taken by Norman the ♀ has been presented to the

British Museum (Natural History) and the ♂ will be presented to the Zoological Survey of India.

2. **Celastrina vipia** sp. nov. This species is described from a single male taken by Norman at Jhakama (5400 feet) in the Naga Hills on 2 May 1950. There is reason to think that it also occurs in north Burma.

DESCRIPTION

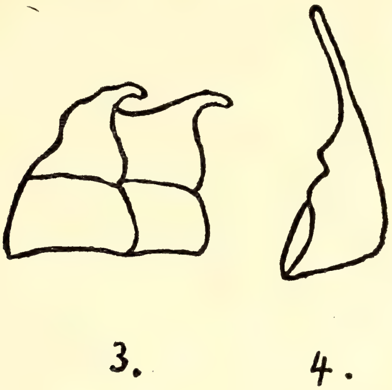
♂. *Upper side :* Fore wing. Pale blue of a shade like *dilectus* Moore from Burma, slightly darker than Assam specimens of *dilectus*. On the disc there is no trace of white nor of paler blue. The black border a thread, expanding to 1½ mm. at the apex. Hind wing. Pale blue, with white streaks in spaces 4, 5, and 6 and sparse white powdering in spaces 2 and 3. A bar is visible at the end of the cell. This facies differs from *dilectus*. In *dilectus*, when the white patch on the disc upper fore is obsolete, there is a patch of paler blue on the disc, sometimes only faintly discernible. Exceptions exist ; one ♂ from Burma and some ♂♂ of the subspecies of *dilectus* from China and SE. Asia have no trace of paler blue on the disc upper fore, but these lack the conspicuous white streaks on the hind wing seen in *vipia*.

Under side : Fore wing. The markings are brown, faint, and delicate, and conform to the usual *Celastrina* (e.g. *cardia*) pattern. The strigae are comparatively long, stretching across the interspaces. The discal band enters space 1 b. The discal spot in space 4 is at an angle of 45 degrees pointing to the spot in space 6. Submarginal lunules present. Hind wing. Markings similar in type to those on the fore wing except that the three basal spots are black. No spot at base of 1 b. Discal spots in 5, 6, and 7 are not in line, that in 6 being shifted in. Submarginal lunules present.

Size and venation : Fore wing. 12 mm. from base to apex. Veins 11 and 12 straight and separate.

Cilia : Chequered at the ends of veins.

Genitalia : Mr. N. Bennett of the British Museum staff very kindly dissected the genitalia in 1952 and prepared the slide from which the figure has been drawn. The figure illustrates the uncus and inside of the left clasp. The general pattern resembles *argiolus jynteana* De N. but the lower broad portion of the clasp differs, lacking the sharp triangular projection so noticeable in *jynteana*. The sharp projection on each side of the uncus ends in a straight point whereas the somewhat similar projection of *jynteana* curves inward like the beak of a bird of prey. The genitalia of *dilectus* are quite different. No genitalia matching this dissection are discernible amongst Chapman's (1909) or Toxopeus's (1927-28) figures, nor among those shown or referred to by Corbet & Pendlebury (1956), nor on the British Museum slides or in the authors' own dissections.



3. *C. vipia:* uncus ; 4. *C. vipia:* medial aspect of left clasp.

In appearance and small size *vipia* is nearest to *ceyx clothales* Frühstorfer from Sumatra, but the genitalia are very different.

The specimen has been presented to the British Museum (Natural History), where it has been lodged since 1951.

3. **Celastrina howarthi** sp. nov. This species is described from a single male taken by Norman on 23 March 1958 at the edge of thick forest in the plains of Sibsagar District, near Amgoorie Tea Estate.

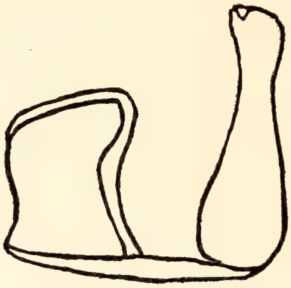
DESCRIPTION

♂ *Upper side :* Violaceous blue, iridescent in certain lights, with a white discal patch on both fore and hind wings. The black terminal border of the fore wing expands gradually and evenly from the tornus to 2 mm. at the apex. There is no black border to the costa of the fore wing. In this respect it differs from *puspa gisca* Früh. which otherwise it resembles above though it is very different below.

Under side : Fore wing. The strigae of the discal band are small, delicate and faint, and do not enter space 1 b. The strigae in 3 and 4 both point to that in space 6. The subterminal markings are a row of faint lunules and an outward row of five strongly marked linear strigae from space 2. Hind wing. No basal spot in spaces 1 b and 7.

Size and venation : Fore wing. 16 mm. Veins 11 and 12 straight and separate.

Genitalia : Mr. T. G. Howarth of the British Museum very kindly made the dissection. The uncus and inside of the right clasp are shown in our figure ; the small triangle at the apex of the clasp, on the edge towards the uncus, is an attempt to show a triangular tip curled in at right angles to the clasp, seen clearly in alcohol. Though clasps of this general shape with serrations and projections from the tip towards the uncus are found in the figures of Chapman, Corbet, and Toxopeus, we have not seen any exactly like it.



5.

5. *C. howarthi:* uncus and medial aspect of right clasp. The triangular process at the distal end, dorsal side, of the clasp actually projects at right angles to the clasp.

Generally speaking, one may say that *howarthi* resembles *puspa* or *albisdisca* on the upper side although below it is very different, while the under side (but not the upper side) resembles *corythus corythus* from Sumatra and *catreus* from Java. It may also be distinguished from these four species by the genitalia.

HESPERIIDAE

4. **Plastingia tavoyana titei** ssp. nov. The new subspecies is described from a single male taken by Norman on 27 April 1954 at Moreh, at plains level in the Kabaw Valley of SE. Manipur. One other specimen, presumed to have been of this species, was seen on the same day.

The clasps of this specimen and the ring spots on the under side of the hind wing show it to be a *tavoyana*, but there are certain differences from the typical form. On the *upper side* of the fore wing the yellow is bright instead of the dark ochreous of typical *tavoyana*, and the yellow streaks along the costa and dorsum are somewhat wider ; on the hind wing the yellow discal area extends further distally, the yellow scales are thicker over the lower part of the cell to the base and the hyaline spot is more elongated. On the *under side* the ground colour is the bright yellow of *noemi* instead of the much darker shade of typical *tavoyana*. The spots in the cell and in spaces 6 and 7 are ring spots. The irregular linear spots in spaces 2 and 3 are on the distal edge of large faint ovoid rings, just as in *tavoyana*, but in this Assam specimen the ovoid rings are obsolescent and discernible only with difficulty.

No example of *tavoyana* has previously been taken north or west of the Karen Hills. The differences are sufficient to give subspecific rank to this specimen. *Tavoyana* Evans will now become *tavoyana tavoyana* Evans. [Both *tavoyana* Evans and *noemi* De N. are dealt with by Evans (1949).]

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge our gratitude to the authorities of the British Museum (Natural History) who have allowed us to examine the specimens in their care ; and particularly to Mr. T. G. Howarth, Mr. G. E. Tite, Mr. N. Bennett, and Mr. J. V. Pearman, who have made the dissections and who have made their time and advice so freely available to us. Two of the names we have used will, we hope, reflect our gratitude in a more permanent form. *Celastrina vipia* has been named after Mr. Vipikhieya Angami, who has captured such a wealth of material for us. The name *baiongus* is derived from the Khasi word meaning ' dark-coloured '.

SELENG T. E.,
SELENG HAT P.O.,
UPPER ASSAM,
April 16, 1960.

KEITH CANTLIE,
C.I.E., I.C.S. (RETD.)
T. NORMAN

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16. ON THE MIGRATION OF THE SWALLOWTAIL, *POLYDORUS HECTOR* (LINNAEUS) [LEPIDOPTERA: INSECTA], OVER SEA[1]

(*With two text-figures*)

Reviewing our existing knowledge of butterfly migrations, Williams (1950) has drawn attention to the need for more precise information from different parts of the world regarding this aspect of insect life. Since the preponderance of existing records pertain to overland migrations, instances of migratory movements over the sea are of special interest.

Williams (1927) cited the few instances on record of the swallowtail, *Polydorus hector* (Linnaeus), one of the commonest butterflies of our plains, undertaking migratory flights overland, and also crossing over the sea between India and Ceylon. Instances of the latter type pertain to sight records or captures made very near the coast with one exception, namely von Frauenfeld's (1867) capture of six individuals aboard S. S. Novara, about 200 miles off Ceylon, on the way to St. Paul. Unfortunately most records are lacking in detail regarding the direction of flight, the prevailing weather conditions, etc. However, on the data available, Williams (1930: 46) concluded that *Polydorus hector* 'passes from India to Ceylon, or vice versa with some regularity in February, March, and April'.

From about the beginning of October, *P. hector* abounds around Mandapam and at any one time of the day several may be seen flitting about the Drumstick Tree (*Moringa pterygosperma* Linnaeus) for which plant, so common on the campus of this Research Station, it shows particular preference, and on one of which I have seen several hundreds roosting on successive nights. To a certain extent, the occurrence of this butterfly also coincides with the commencement of the NE. monsoon. On several occasions in October 1959 I observed regular flights of *P. hector* from the mainland in the direction of the chain of coral islands lying off the Ramnad coast in the Gulf of Mannar (Text-fig. 1). Subsequently I was able to make more detailed observations on five days while out at sea in this area and these are summarised below:

5 *November* 1959. Time: 09.00 to 11.30 hours. Place: half-a-mile out at sea between CMFRS[2] and Vedalai. Several *P. hector*

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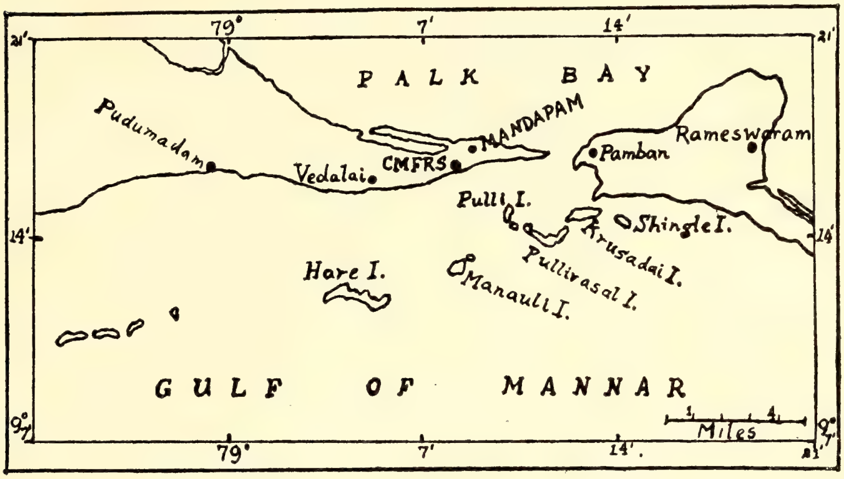
[1] Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

[2] Central Marine Fisheries Research Station.

were seen migrating from the mainland towards Manauli and adjacent islands; flight thin and diffuse (4 to 6 noticeable at a time); course steady without any deviations; flight 3 to 6 metres above sea-level. None seen approaching mainland. Weather: sky overcast, calm, with hardly any breeze. Temp.: max. 29° C.; min. 26° C. Humidity 90%[3].


79°
7'
14'
21'
PALK BAY
Pudumadam
MANDAPAM
Rameswaram
Pamban
Vedalai
CMFRS
Pulli I.
Shingle I.
Krusadai I.
Pullivasal I.
Manauli I.
Hare I.
14'
GULF OF MANNAR
1
4
Miles
9° 7'

Text-fig. 1. Map showing part of the Ramnad Coast and the adjacent islands in the Gulf of Mannar.

6 *December* 1959. Time: 09.15 to 11.30 hours. Place: same as on 5-11-'59. Migration of *P. hector* from mainland to islands, numerically more than on previous occasion, 36 being counted within 3 minutes. Flight steady, low, not more than 2 to 3 metres above water level. Weather: sky slightly overcast; steady breeze from mainland. Temp. max. 29° C.

21 *January* 1960. Time: 09.30 to 11.30 and 14.30 to 17.15 hours. Place: to and fro between CMFRS and Pudumadam about 12 miles SW. along Ramnad Coast. Weather: Sky slightly overcast in the morning, clear in the afternoon, Temp.: max. 29° C., min. 24° C. Humidity 90%.

Numerous *P. hector* were seen migrating from Manauli and Hare Islands towards the mainland between 09.30 and 11.30 hours. From the boat travelling at a speed of 6 knots, 67 butterflies were counted in a period of five minutes. One apparently completely exhausted alighted on the water with wings spread out within five metres of the boat, but was seen in a few seconds to take off, its flight at first being a bit erratic, but when last seen it was flying vigorously towards the mainland which was about a mile away from the place of observation. None seen flying more than three metres above water level, while most kept very close to the water on account of the fairly strong head wind. The fact that none of the butterflies was encountered while travelling opposite the gaps between the islands strongly suggests that they cross in a more or less straight line course from the islands to the parts of the mainland just opposite. During this period of observation, not a single individual was seen flying from the mainland to the islands.

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[3] Data regarding temperature and humidity pertain to Pamban as given in the Regional Daily Weather Reports of the Regional Meteorological Centre, Madras.

On the return trip from Pudumadam to CMFRS between 14.30 and 17.15 hours none was seen in flight crossing over to the mainland or vice versa.

29 *January* 1960. Time: 17.45 hours. Place: about 3½ miles from the mainland towards Manauli Island. Weather: strong wind blowing from the mainland and choppy seas. Temp. max. 29° C., min. 25° C. Humidity 80%. One dead *P. hector* was seen floating. None seen in flight between mainland and Manauli Island between 16.45 and 18.00 hours.

31 *January* 1960. Time: 12.00 hours. Place: 2 miles from Manauli Island towards mainland. Weather: Sea relatively calm; steady breeze blowing from the mainland. Temp. max. 29° C., min. 25° C. Humidity 85%. Three *P. hector* were seen almost at the same time, all flying about 2 metres above water and heading towards Manauli Island. None seen crossing in the opposite direction.

From about the last week of January these butterflies appeared to be much fewer in numbers in the campus area and on two trips made to Pudumadam on 6 and 11 February none was seen in flight over the sea. After a few weeks' absence, on my return to Mandapam in the last week of March, I found that they had almost completely disappeared from the scene

The above observations and the many reports I have received from my co-workers going out on regular fish and plankton collections point definitely to a migratory movement of the swallowtail north to south, from the mainland to the chain of islands mentioned above, and at certain periods vice versa. A few noteworthy features are:

1. The migration is thin and diffuse with generally 5 or 6 individuals visible to the observer at a time.
2. The steady and non-deviating pattern of flight.

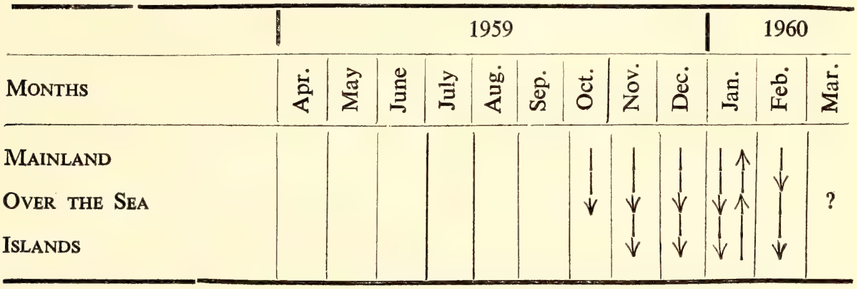
3. When there is a strong head or tail wind, the butterflies keep as close to the water as possible.

4. When on sea, the direction of flight of a single individual is typical of the direction of the whole flight at a particular time.

5. The to and fro flights between the mainland and the islands may be indicative of 'return' flights.

6. It appears likely that, when exhausted in flight, they alight on the water for shorter or longer periods as seen in one instance on 21-1-'60.

7. The peak activity appears to be from November to about the middle of January. However, it is not known whether this would change from year to year, for Williams (1930) records February, March, and April as the months during which migratory flights of this species between India and Ceylon and vice versa take place.



Text-fig. 2.

(Arrows indicate direction of flights in the different months)

8. Not once did I see *P. hector* being preyed upon when in flight over the sea. This is quite unlike what Evershed (1912) found for this species on its overland migrations especially when migrating across Palni Hills, south India, when it is specially liable to attack by birds.

9. All migratory flights over the sea were observed during the earlier half of the day and hardly any after 14.00 hours.

The voluntary nature of these flights and the purposeful manner in which they are carried out would amaze any observer. We do not know why this or for that matter many other species voluntarily migrate over sea and our knowledge about migratory movements is incomplete on several scores, such as the periods when these migratory flights are undertaken, the size of migratory movements, whether in this case the chain of islands act as only a stepping stone for the colonisation of areas beyond and vice versa, whether those that undertake the flights are surplus populations from overpopulated areas, the relationship between migration and breeding area, whether the return flights are undertaken by the same individuals, whether there is any difference between the migrants and non-migrants in this species, the size, age, and maturity of migrants, the sex ratio of the migrants, their survival rate, whether at any time more than one species is involved in these migratory flights, whether they resort to nocturnal migratory flights, the influence of weather conditions on the pattern of migration, etc. I hope that this note will create an urge in some of our readers to observe and try to unravel the mysteries of this aspect of butterfly life, which is as fascinating as the study of other animal migrations.

CENTRAL MARINE FISHERIES RESEARCH STATION,
MARINE FISHERIES P.O.,
MANDAPAM CAMP,
March 31, 1960.

E. G. SILAS

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[Dr. C. B. Williams asked for information about insect migration in a paper published in this journal in 1938 (*J. Bombay nat. Hist. Soc.* **40**: 439-457. The migration of butterflies in India,) and the request is repeated in his book on insect migration, a review of which appears elsewhere in this issue. The particulars required are briefly indicated by the headings of the standard form in which he files details of the records received: year, month, date and time of day, locality, direction of flight, direction and strength of wind, numbers seen, number captured and where they are kept, sex, condition (fresh, worn), notes (extent of flight, speed, pairing, egg-laying, etc.), present and past weather conditions (temperature, rain, sun, cloud, thunder, barometer, etc.), height above the ground/sea, name and address of observer, name of species, other species in the flight (name and number), identified by. All information should be put down at the time of the observation or as soon thereafter as possible. Specimens should be captured and sent in; as many as fifty is not too much and some of them should be preserved in spirit for examination for fat reserve and state of development of the eggs. Specimens are of value even if they are not in perfect condition. If the flight lasts over several days observations should be made as to the earliest and latest hours of activity and attempts should be made to discover what the insects do at night.—EDS.]

17. INSECT-BIRD ASSOCIATIONS WITH NESTS OF LARGE RED ANTS [*OECOPHYLLA SMARAGDINA* (FABRICIUS)]

Charles Barrett & A. N. Burns (1951) in BUTTERFLIES OF AUSTRALIA AND NEW GUINEA (N. H. Seward Pty. Ltd., 457 Bourke Street, Melbourne) refer to the moth butterfly (*Liphyra brassolis major*) laying eggs singly on twigs and leaves of trees bearing nests of the green tree-ant (*Oecophylla smaragdina*)—they refer, presumably, to *O. smaragdina* var. *virescens*, which occurs in Australia. When freshly emerged the butterfly has numbers of special dehiscible scales, which prevent the true scales from being injured by the ants whilst the butterfly is crawling through and out of the nest when emerging.

The larvae feed on the larvae of the tree ant, the body juices of which are sucked up; they are enemies of the ants, whereas all other Lycaenid larvae which live in association with ants are their friends, because they supply them with a sweet exudation from glands on the posterior portion of their bodies. A more detailed report of this is said to be contained in an article, 'The Green Tree-ants' by Frederick P. Dodd, published in the *Victorian Naturalist* (September 1928).

In addition to the Rufous Woodpecker (*Micropternus*) which lays its eggs within the nest of the red *Crematogaster* ants, I have seen nests of different species of sunbirds (*Leptocoma* spp.) hanging very close to the green leaf-nests of the large red ant (*Oecophylla smaragdina*). Unfortunately, the actual distances were not recorded nor any of them kept under observation, but my impression that they were too close to be due to accidental circumstances is shared by my brother Shumoon who has done a fair amount of bird-nesting around Bombay.

It is also true that few of the mango trees around Bombay are free from these red ants and bird-nesters have all been well bitten while climbing to examine nests of drongos, doves, tree-pies, etc., etc. Surely, some form of armistice must prevail; otherwise, it appears impossible that any of such nests would survive.

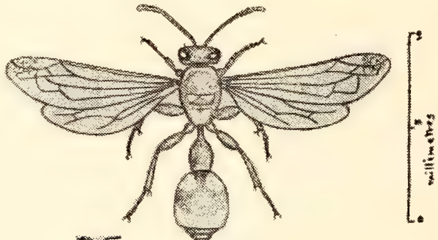
It is well known that doves, munias, and such other 'harmless' birds often build their nests touching those of kites, eagles, and other birds of prey. I do not remember having read of the eggs or young being taken, and such nesting is definitely under armistic terms.

c/o Faiz & Co.,
Abdul Rehman Street,
Bombay 3,
February 27, 1960.

HUMAYUN ABDULALI

18. TWO SOCIAL WASPS: *ICARIA VARIEGATA* (SMITH) AND *POLISTES STIGMA* (FABRICIUS)

Icaria variegata (Smith) is a small reddish brown wasp about 7 mm. long with yellow markings, warning colours adopted by most of its relatives. It has the usual 'wasp waist', a long stalk with a smaller, then a larger bulge. The yellow is in two spots at the base and a band at the end of the large bulge, with marks on the thorax. It has the habit of drawing in the end segments of the abdomen into the large bell-shaped second segment.



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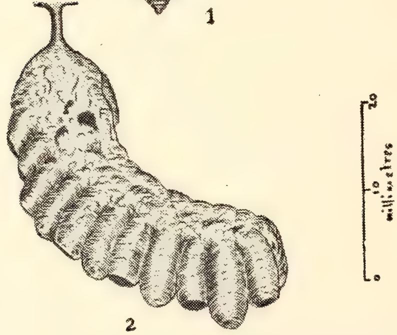

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Fig. 1. *Icaria variegata* ♀ ; Fig. 2. Nest of *Icaria variegata.*

The nest is placed in the open, without any attempt at concealment, hanging from the underside of a leaf, or in some sheltered position. It is made of a papery substance, formed by the wasp itself by chewing up wood and mixing it with saliva. It consists simply of three or four irregular lines of cells, upside down, hanging from one end. More are added on at the far end as the colony grows.

As is well known in the case of honey bees, the colony cannot be moved short distances. I have tried on several occasions moving a nest about 100 yards, but without success. The wasps on leaving the nest in its new position, find themselves in familiar surroundings. They know well the way 'home', i.e. to the original site, and there they return looking in vain for the departed nest. If, however, the nest is moved far enough, the wasps find themselves in a strange country. They hover round the nest learning its new position, to which they will return as they see no familiar landmarks to lead them to their original 'home'.

I moved a colony successfully from a distance of about two miles on 25 March 1957. There were at that date about 23 cells, 5 being capped over and containing pupae, 6 or 7 deep uncapped, some of which contained larvae or eggs, and another 10 or 11 begun or damaged. There were 7 wasps on the nest.

On watching carefully it seemed that two kept constantly on the nest, and that one kept chasing the other, as if to drive it away. To make observation easier, I marked these two on the thorax with a dab of blue and green paint respectively. I have read of a queen wasp (*Polistes*) taking possession of another colony (Yoshikawa, K: Insects sociaux **2**: 255) and I wondered whether this is what may have been taking place here. It is difficult to distinguish the queen, as there is no difference in the markings and only 2 or 3 mm. difference in length. The blue queen was seen to go for a short flight of a minute or two on two occasions. Eventually on 13 April she drove off the green queen and was left in possession.

The workers are often off the nest. On their return the queens get very excited. As the worker arrives, a queen makes a fierce rush at it, climbs on its head, often standing on the eyes (a proceeding which seems to cause no inconvenience to the worker) and curls round so as to put her mouth to the worker's mouth. A drop of transparent fluid then passes from the worker to the queen and her hunger is appeased for the moment. On one occasion I saw a worker feed both queens in succession.

If possible the worker will avoid the queen and go to one of the larvae. A caressing movement of the antennae causes the larva to put its head to the mouth of the cell, and the worker then feeds it, in the same way as it feeds the queen, with a drop of fluid. I could see no difference, using a lens, between the feeding of the larva and the queen. On some occasions it seemed as if a queen would get a drop of fluid from one of the larvae.

When about to pupate, the larva caps over its cell by itself. In the instance I watched, the green queen stood over it for a long time apparently watching, but not helping at all. At 11 a.m. the larva was weaving a loose mesh of silk which it seemed to press together later. At 12.15 it was still working, the silk fairly thick, but with a hole remaining in the centre. By 1.30 the entire cell was capped. The eggs are white and oblong, and are attached to the base of the cell. The larvae look pinkish at one stage, but white when full grown with a dark head.

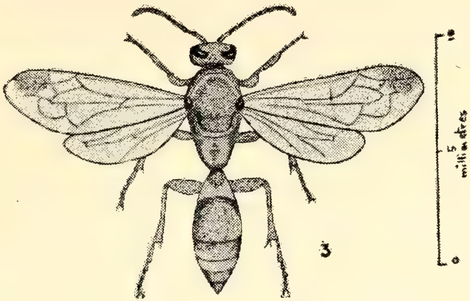
In a colony which I was keeping in March 1960, I noted that the newly-emerged wasps seemed to have black eyes, which gradually became light and mottled in appearance as in the older wasps. While the eyes are black, they do not seem to leave the nest. I also noticed one morning two or three very small insects emerging from a hole in the top of the nest. They seemed to have torn the hole from inside one of the cells. The wasps were much excited; one had caught an insect and was chewing it up with the mandibles. The insects were black, about 2 mm. long, and may have been parasitic wasps or flies.

In contrast to *Icaria*, *Polistes stigma* (Fabricius) has no 'stalk', the abdomen being close to the thorax, though of course with the 'wasp waist'. It is also reddish with yellow markings on the thorax and a broad band of yellow on the abdomen. The worker measures about 10 mm.

It builds a circular nest, consisting of a bunch of cells, mouth downwards, attached by a stalk to the underside of a roof or arch in a sheltered position. When the cell is capped the silk continues the wall of the cell, making it almost twice as long as when uncapped. The white silk of the cap contrasts with the greyish paper of which the cell is made.

On 2 February 1960 I picked up a nest which had been broken off from its position and was lying on the ground. The wasps, of course, had flown away. However, the nest contained capped cells, larvae, and eggs, so I hung it up by wire in an observation box. The next day 3 pupae hatched out. As there were no workers or queen, I wondered how to feed these wasps. I tried with a drop of sugar water on a needle, and I thought once or twice some was taken, but could not be sure. The following day, one of them solved the problem by pulling out a well-grown larva from a cell and proceeding to eat it, holding it in its forelegs. It was soon joined by another, and the two soon finished off their meal.

On 6 February 1960 several more wasps emerged, together with two flies like large house flies, evidently parasitic on this wasp. They did not rest on the nest, but remained on twigs near by, drying their wings before flying off. By 19 February there were 19 wasps on the nest, of which at least 5 were males. I could see 8 eggs and 3 larvae. The feeding process was much the same as in *Icaria.* These wasps seem often to preen each other, gently scraping with the mandibles on the clypeus especially, the eyes, and the thorax. Curious behaviour noted on several occasions was when one of the workers seized a male by the base of the antenna and held it for a considerable time, the male now and then making feeble attempts to escape.



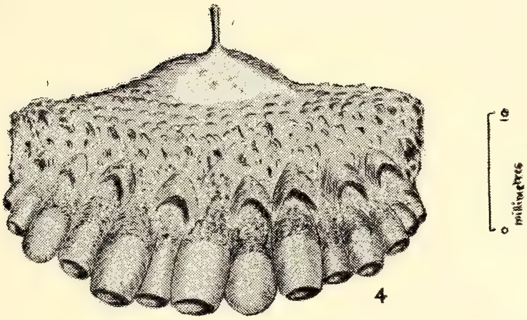


Fig. 3. *Polistes stigma* ♀ ; Fig. 4. Nest of *Polistes stigma*

The workers, which are imperfectly formed females, are not capable of being fertilised. Nevertheless on occasion they will lay eggs. As is well known in the case of honey bees these unfertilised eggs develop into males. In the *Polistes* nest there was no queen, but the workers laid a considerable number of eggs, white ovals, glued to the side, not the base of the cells. The experiment did not last long enough to know if or into what these eggs would develop. The colony seemed lethargic, and not many individuals were out foraging. I noticed several wasps devouring one of the larvae. The numbers dwindled until on 29 February only 11 remained, and that afternoon they all left the nest, none remaining in the evening. On that date there were 34 eggs and 9 larvae in very early stages. The two following days two wasps were seen to return to the nest for a time, one even feeding the other on one occasion, but after 2 March the nest remained completely deserted.

ST. JOHN'S MISSION HOUSE,
POONA, F. L. WAIN, S.S.J.E.
March 29, 1960.

19. *RHYNCHOSIA SERICEA* SPAN.: A NEW RECORD FOR BOMBAY STATE

Rhynchosia sericea Span. in Linnaea **15**: 195, 1841; FBI. **2**: 225; Duthie, Fl. Upper Gang. Plain **1**: 222, 1903. *Dolichos tomentosus* Roth, Nov. Pl. Sp. 345, 1821; DC. Prodr. **2**: 401, 1825; Wt. & Arn. Prodr. **1**: 248, 1834. *Rhynchosia tomentosa* Kurz in JASB **43**: 186, 1874 (non Hook. & Arn. 1835).

A large woody twiner, reaching 3-6 m. high; stems much branched, younger parts clothed with soft, short, greyish brown, glandular hairs, older ones nearly glabrous; internodes 4.5-15 (12.5) cm. long, often twisted. Leaves alternate, trifoliate; rachis 4-11 (8) cm. long, densely hairy; leaflets 4-17×1.7-6-13 (10×7.3) cm., softly pubescent on both surfaces, densely beneath; terminal leaflet largest, ovate or ovate-rhomboid, equal-sided, lateral ones obliquely ovate; apex acute or slightly acuminate; base rounded, truncate or subcordate; stipules 0.5-1.5 (1) cm. long, persistent, broadly ovate or lanceolate, acuminate, hairy on the margins; stipels 0.2-0.4 cm. long, filiform, persistent. Racemes 4-20 (13) cm. long, compact, simple or branched, axillary; floral-axis villous, terete. Flowers 10-25, subpedicellate, bracteate; pedicels about 0.2 cm. long, pubescent, reflexed in fruit; bracts about 0.5 cm. long, ciliate, caducous. Calyx 0.6-0.8 cm. long, persistent, rufous-pubescent, campanulate, of five unequal teeth; tube about 0.4 cm. long. Corolla yellowish brown, purple tinged; standard about 1.4×1.1 cm., wedge-shaped, with two distinct callosities before tapering at the base into a short claw; wings 1×0.3 cm., ovate-linear, spurred; keel 1.3×0.3 cm. Stamens about 1.3 cm. long, monadelphous. Ovary densely whitish-tomentose with a filiform style. Pods 2-3-seeded, 2-3×0.5-0.8 (2.5×0.6) cm., straight or falcate, compressed, with a long apiculation, densely-pubescent, villous on the margins with spreading white or pale brown hairs; seeds 2, estrophiolate, about 0.4 cm. across, nearly orbicular, dark brown.

This plant is not recorded in our floras. From the available data, it occurs in Poona, Bombay, Salsette, and southern Gujarat. The plant is neither common nor abundant.

Flowers: September-November. *Fruits:* September-December.

Herbarium specimens examined: Santapau 12048 (Poona) and 19427, 20019-23, 20274-20275 (Dangs Forest); *Panthaki* 2235-37 & 2408 (Dangs Forest); *Shah* 7510-11 (Malad); *Shenoy* 4759-61 (Mumbra).

World distribution: India and Malaya.

Critical notes: In general appearance and habit this plant resembles *Rhynchosia bracteata* Bth.; the latter, according to Cooke, is very rare. The following are the differences between the two:

R. sericea: Stems clothed with glandular, greyish brown hairs; stipules persistent, broadly ovate or lanceolate; leaflets 4-17×1.6-13 cm.; corolla about 1.4 cm. long.

R. bracteata: Stems not glandular-pubescent; stipules minute, caducous; leaflets 5.8-11.6 cm. long and broad; corolla about 1.2 cm. long.

St. Xavier's College,
Bombay 1,
April 15, 1960.

G. L. SHAH, M.SC.
D. P. PANTHAKI, M.SC.

20. A NOTE ON THE OCCURRENCE OF *ACANTHOSPERMUM HISPIDUM* DC. IN RAJASTHAN

(*With a plate*)

Acanthospermum hispidum (Compositae) a native of S. America made its appearance recently and established itself very well in several parts of India. The plant has been observed by us for the first time in Pilani in the vicinity of Birla College, in September 1955. Now this plant is very well established in several localities in Pilani and its neighbouring places. No reference to this plant is made in any of the standard works, which we have consulted, on the plants of the Indo-Gangetic plain and Rajasthan, and a complete description of the species is not available in any of the Indian floras. Therefore, the present note is called for.

A. hispidum: Annual herbaceous weed; *stem* 30-45 cm. long, dichotomously branched, terete, hairy, hairs slightly stiff; *leaves* simple, opposite, sessile, lamina with three prominent veins, obovate or nearly so, gradually narrowing towards the base, 3.2-4.7×2-3 cm., hairy on both surfaces, margins, serrate; *heads* in the forks of stem, solitary, radiating, about 5-6 mm. across, heterogamous, involucre 5-7 in number; *flowers* yellow, peripheral female flowers 7, very rarely 5, corolla strap-shaped, sometimes persistent disc florets minute 10-15, functionally male with abortive ovaries, corolla tubular, five-toothed; stigma papillose; cypsela 5 mm., compressed, bristly with two horn-like spines at the top, pappus absent.

Flowers and Fruits: August-November.

Ecological notes. The plant is not abundant nor common. It is generally found in waste places, roadsides, and open plain ground, often in association with *Tephrosia purpurea* Pers. Pure stands are rarely met with. Not eaten by livestock. Fruits distributed by sheep and cattle.

DEPARTMENT OF BOTANY,
BIRLA COLLEGE,
PILANI,
November 4, 1959.

N. C. NAIR
M. B. DESHPANDE

21. ON THE NOMENCLATURE OF *JASMINUM VIRGATUM* KERR.

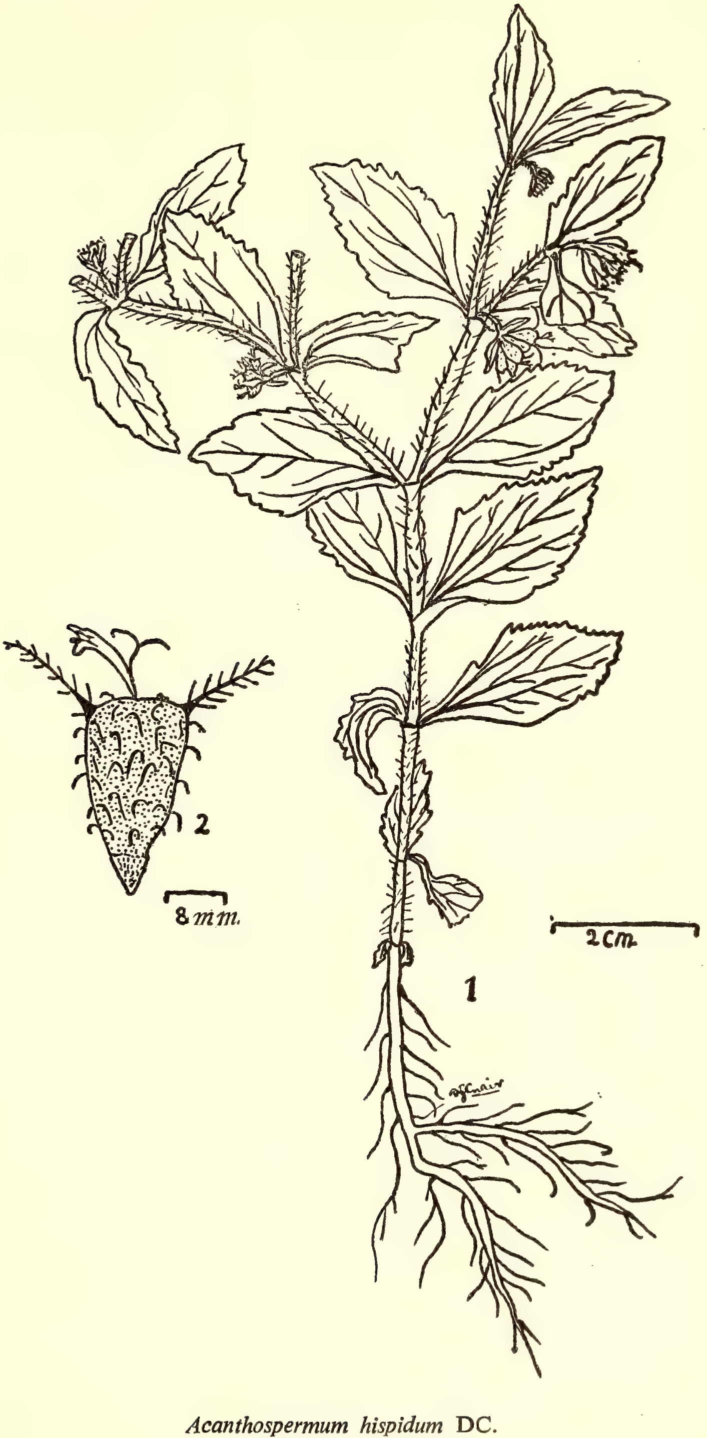
INDEX KEWENSIS (1947) lists *Jasminum virgatum* Kerr. (1938) from Siam (now Thailand) and *J. virgatum* Knobl. (1936) from Tanganyika. Evidently the same name has been used for two plants from widely separated localities which, from their respective descriptions, appear quite different from each other.

According to Art. 64 (2) of the *International Code of Botanical Nomenclature* (ed. 1956) *J. virgatum* Kerr. must be rejected, it being a later homonym of *J. virgatum* Knobl. In 1952 Turrill & Milne-Redhead reduced *J. virgatum* Knobl. to the synonymy of *J. stolzeanum* Knobl.; even so the later homonym must be rejected in accordance with the second paragraph of Art. 64 (2).

As far as I am aware, *J. virgatum* Kerr. has neither been renamed nor been merged in the synonymy of any other species. I, therefore, rename *Jasminum virgatum* Kerr. (in Kew Bull. 1938: 31-32) as *Jasminum kerrii* nom. nov. The type of the species is *Kerr* 8580 in Kew Herbarium.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
June 22, 1959.

G. S. BHATNAGAR



Acanthospermum hispidum DC.
1. Entire plant ; 2. Fruit.

22. *MERREMIA TUBEROSA* (L.) RENDLE: AN IDEAL CREEPER FOR THE PLANT-HOUSE

(*With a photograph*)

Many of our ornamental palms, crotons, begonias, gesnerias, and other plants suffer heavy casualties in India during the hot and dry months of summer. The practice commonly followed for their protection is to construct a plant house with wooden or iron poles with wire-netted covering all round and to allow some kind of creeper to grow on them. The ornamental plants are kept inside such plant houses. If the heat is too much and the plants still suffer, additional shade is created by putting a thin layer of straw or *Kans* grass on the roof and these are kept in position by tying them on the wire netting and keeping them flat with the help of split bamboos. The creepers commonly used for shade on these plant houses are the Sandwich Island Creeper (*Antigonon leptopus*), the Golden Shower (*Pyrostegia venusta*), the Railway Creeper (*Ipomoea palmata*), the Bridal Creeper (*Porana paniculata*) and the Rangoon Creeper (*Quisqualis indica*). Some other creepers and twiners are also used for the same purpose, such as *Bignonia unguis-cati, Derris scandens, Ipomoea hederacea, Jasminum pubescens, Passiflora coerulea,* etc.

All these creepers, when fully grown, have their good and bad points. Some are found to be slow growing, others do not spread rapidly and remain somewhat thin. Others are not hardy enough to withstand the strong sun, while some are considered too leafy. Therefore garden lovers and particularly those in charge of such plant-houses are constantly on the look-out for better and more desirable creepers. One such creeper which is considered very good from a number of points of view appears to be the plant commonly known as *Ipomoea tuberosa* of the family Convolvulaceae. The plant was originally a native of the West Indies and South America and is now found naturalised in many tropical countries like tropical Africa, the Mascarene Islands, India, Ceylon, and Malaysia. Many years ago it was introduced into India but its great value was apparently not fully appreciated.

Although the plant was not expected to occur in cold countries like England, it is interesting to note that for a long time its seeds and fruits were regularly found on the shores of the Orkney Islands and the Hebrides situated on the north of Great Britain. The occurrence of these seeds so many hundred miles away from the West Indies remained a mystery for a long time and towards the end of the last century it was Sloane who established that the seeds and fruits must have reached these islands by the effective floating device of the fruits and by the action of the Gulf Stream. In 1872, Hemsley identified the seeds and fruits as those of *Ipomoea tuberosa*. An admirable account of the distribution of these seeds has been given by Guppy (1917).

The plant appears to have been introduced in India by the Botanic Garden at Calcutta about the year 1840 and has been mentioned in the list of plants found growing in the Garden in 1843. It is a vigorous climber and is grown from seeds which are hard and black. It is a perennial and develops a large underground tuber. The leaves are deep green in colour and almost palmate and the flowers are slightly fragrant and golden yellow. They are usually borne singly or in twos on axillary flower stalks (see photo).

Merremia tuberosa (L.) Rendle : an ideal creeper for the plant-house

The plant has been mentioned by Cooke as a cultivated plant in Bombay and was also described by Woodrow in his book on gardening in India in 1899. Apparently the species lost favour in the years that followed, as it has not been mentioned in Bor & Raizada's admirable book on Indian climbers and shrubs. Being an exotic climber, it was also not expected to occur in the interior of Bombay State and therefore was not listed by Santapau in his work on the Khandala flora. Santapau (1947) has however discussed the nomenclature of this plant in his paper dealing with the Convolvulaceae of Bombay. In Calcutta, the plant also lost its popularity for many years as it was not noticed in private and other gardens and the plant or plants which once existed at the Botanic Garden were destroyed. It was therefore necessary to reintroduce the plant in the Indian Botanic Garden, Calcutta, and this has been done recently with seeds secured through the courtesy of Shri M. S. Sivaraman, I.C.S., Adviser to the Planning Commission, New Delhi. At present two such plants are growing vigorously inside the garden and producing flowers and seeds. The creeper is found to be almost ideal for the plant house and it helps in reducing the inside temperature of the plant house by 5 to 10 degrees. Small quantities of seeds are available for distribution. The correct name and synonymy of the plant is given below:

Merremia tuberosa (L.) Rendle in This.-Dyer, *Fl. Trop. Afr.* **4 (2)**: 104 (1905); Van Oostroom in *Blumea* **3**: 325 (1939); Santapau in *J. Bombay nat. Hist. Soc.* **47**: 345 (1947).

Ipomoea tuberosa Linn. in Sp. Pl.: 160 (1753); Cooke in *Fl. Bomb.* **2**: 251 (1905).

Convolvulus tuberosus Spreng. Syst. **1**: 591 (1825).

Operculina tuberosa Meissn. in Mart. *Fl. Bras.* **7**: 212 (1869).

INDIAN BOTANIC GARDEN,
BOTANIC GARDEN P.O.,
CALCUTTA,
April 19, 1960.

D. CHATTERJEE,
Superintendent

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23. NEW PLANT RECORDS FROM GUJARAT

1. *Nicotiana plumbaginifolia* Viv. (Solanaceae).

During one of our local botanical excursions, we came across a few plants of *N. plumbaginifolia* Viv., which were found occupying the banks of a water stream in the most shaded and undisturbed portions of the Navlakhi area in the L.V. Palace compound. The plant was first thought to be an escape of some cultivated species of *Nicotiana.* Later on the same plants were also collected from a few places on the banks of the River Vishwamitri. This plant has a restricted area of distribution.

The genus *Nicotiana* is represented by three species in India, out of which *N. tabacum* Linn. and *N. rustica* Linn. are cultivated forms exhibiting very little tendency to spread as weeds. According to Hooker (in F.B.I.), the third species, viz. *N. plumbaginifolia* Viv. is 'an introduced weed commonly found in Bengal and is the only species of *Nicotiana* which has established itself in India'. Kashyap (1924) remarks that the plant is quite common near Lahore. Raizada (1931) reports that it is 'completely established as a weed of waste places round about Dehra'. Pattnaik (1956) has included it in his list of the useful weeds in and around Cuttack, which means that the plant is fairly common there. Cooke (1908) does not mention it in THE FLORA OF THE BOMBAY PRESIDENCY. Santapau (1948) does not record any wild species of *Nicotiana* in his notes on the Solanaceae of Bombay. The plant, a native of Mexico and West Indies, is a medium-sized erect herb with narrow, linear, pinkish white flowers in lax racemes. The leaves are either oblong or elliptic with a narrow base.

No wild species of *Nicotiana* has been recorded by any of the previous workers on the flora of Gujarat and, as far as the authors are aware, the plant mentioned above is a new record for Gujarat or possibly for the whole of Bombay State.

2. *Eleocharis fistulosa* Link. (Cyperaceae).

The plant was first collected from a pond on the outskirts of Baroda city and was growing as an amphibious hydrophyte in association with *Cyperus esculentus* and *Eleocharis plantaginea,* from which it could not be easily distinguished. It has been observed that the plant has not yet spread much and has a localized area of distribution.

Out of the eight species of the genus *Eleocharis* reported from the Bombay Presidency, only three species, viz. *E. plantaginea* R. Br., *E.*

atropurpurea Kunth., and *E. capitata* R. Br., are reported to occur in Gujarat. *E. fistulosa* Link., which is hitherto recorded from a few places in W. Ghats, Southern Mahratta Country, and North Kanara, is for the first time recorded from Gujarat.

E. fistulosa Link. is a stout, stoloniferous sedge with a solitary, terminal spikelet as in most of the species of the genus *Eleocharis.* The stem is triquetrous (unlike *E. plantaginea*) and is of a pale green colour. The plant was found profusely flowering in the months of August and September.

Thanks are due to the Director, Sibpur Botanic Gardens, Calcutta, and Shri M. B. Raizada, Officer-in-charge, Botany Section, Forest Research Institute, Dehra Dun, for the confirmation of the identification of the plants.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
November 12, 1959.

A. R. CHAVAN
S. D. SABNIS

[*Nicotiana plumbaginifolia* Viv. is a garden plant commonly cultivated in gardens in most parts of India; from such gardens it has escaped and become naturalized particularly in the eastern parts of the country. This is the first time the plant has been mentioned as growing wild in Bombay; it has been known as a garden plant for a long time.—EDS.]

24. *ARTOCARPUS HETEROPHYLLUS* LAMK.

(*With a plate*)

This tree is often listed in our popular floras under the names of *A. integrifolius* or *A. integra.* Miss F. M. Jarrett of Arnold Arboretum and Kew Herbarium has recently published a revision of *Artocarpus*, from which I extract the following data on the nomenclature of our plants:

(*a*) **Artocarpus heterophyllus** Lamk. Encycl. **3**: 210, 1789; Jarrett in Journ. Arn. Arbor. **40**: 334, 1959. *A. integrifolia* Linn. f. var. b. *heterophylla* Pers. Syn. Pl. **2**: 531, 1807. *A. integrifolia* auct. mult. non Linn. f. *A. integer* mult. auct. non Merrill, sensu Merrill, Interpr. Rumph. Herb. Amb. 190, 1917.

This is the commoner species of the genus in western India; it is quite different from the following.

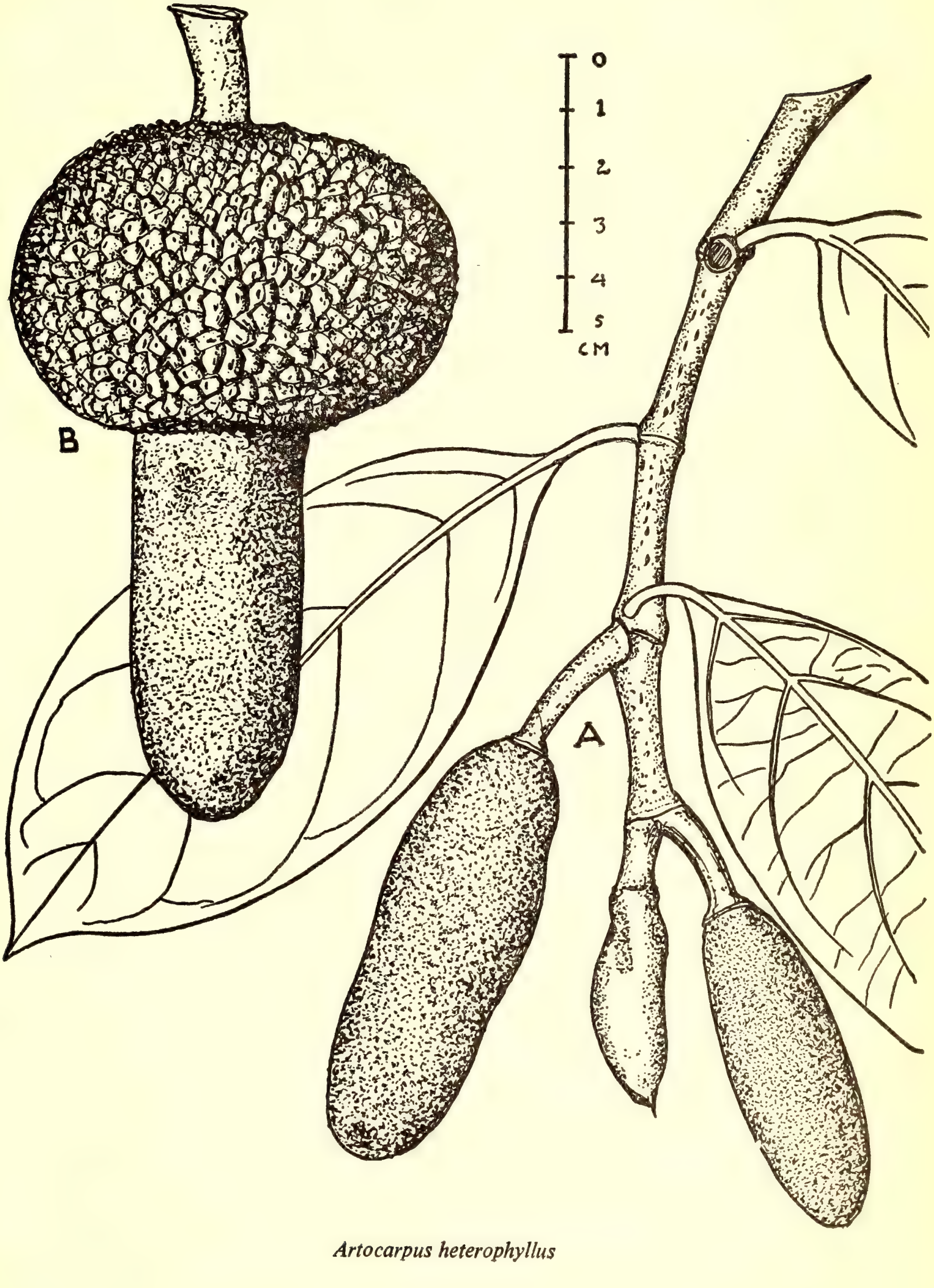
(*b*) **Artocarpus integer** (Thunb.) Merrill, Interpr. Rumph. Herb. Amb. 190, 1917; Jarrett, loc. cit. 329. *Rademachia integra* Thunb. in Vet. Akad. Handl. Stockholm **37**: 254, 1776. *Artocarpus integrifolia* Linn. f. Suppl. 411, 1781, nomen illegit.

These two plants have often been confused in the literature; the differences between the two species are given by Jarrett in her key, pp. 135-136, as follows:

'Twigs and peduncles usually pilose from patent, rufous hairs, c. 3 mm. long; base of leaf abrupt, intercostals to c. 10, inflorescence without a basal annulus ...	*A. integer*
'Twigs and peduncles glabrous, base of leaf decurrent, intercostals c. 10-14; inflorescence with a basal annulus formed by the enlargement of the top of the peduncle into a narrow flange ...	*A. heterophyllus*'

The geographical distribution of these two trees is the following: *A. integer* is apparently indigenous in evergreen forests 1500 to 4000 ft. in Sumatra, Borneo, Celebes, Mollucas, and New Guinea; it is cultivated throughout Malaysia and the Philippines. *A. heterophyllus* is 'possibly indigenous in evergreen forests from 1500 to 4000 ft. on Western Ghats of India; becoming naturalized sparingly in evergreen and semi-evergreen forest and tolerant of the dry season; cultivated throughout the tropics.' (Jarrett, op. cit. p. 336.)

According to the information available to me, these trees are monoecious, i.e. male and female flowers are found on the same tree, but the sexes are separate on different receptacles or inflorescences. Recently I have had occasion to examine several trees of *A. heterophyllus* cultivated in St. Xavier's Villa, Khandala, on the Western Ghats of India. One tree called my attention strongly; it was loaded with small 'fruits', some of which were collected and examined in detail. The results of this examination showed a peculiarity that has apparently been missed in our floras; the results are embodied in the plate that accompanies this short note. Some of the 'fruits' were in fact male inflorescences (fig. A in plate), consisting of very numerous male flowers, the anthers of the stamens being clearly visible to the naked eye. Other 'fruits' consisted of female flowers, the styles and stigmas being quite clear. But a third group of such 'fruits' consisted of female flowers below near the base, and male flowers above (see fig. B in plate), the part of the female flowers bulged considerably, as may be seen in the illustration. The tree under examination had about 20 female inflorescences or developing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A

Artocarpus heterophyllus

'fruits', some of which were already 20×12 cm. in size; at or near the ends of the branches all the inflorescences were male; scattered on the trunk and branches were 6 mixed inflorescences of the type shown in the fig. B in the diagram. Material was collected and is now preserved in Blatter Herbarium with reference numbers *Santapau* 23356-23357, Khandala 20 February, 1960.

This is the tree known in English as the *Jack Fruit Tree*, in local Marathi *Phanas*. It is the species of *Artocarpus* commonly cultivated along some of the Bombay streets and in local gardens. The 'fruit' is edible and attains sizes of up to 45×30 cm., though much larger sizes are occasionally seen in the local markets.

ST. XAVIER'S COLLEGE,
BOMBAY,
March 2, 1960.

H. SANTAPAU

25. AN UNUSUAL INFLORESCENCE OF *CASUARINA EQUISETIFOLIA* LINN.[1]

(*With a photograph*)

An unusal inflorescence of *Casuarina equisetifolia* Linn. was collected from the Central Marine Fisheries Research Station campus on 12 November 1958. The inflorescence is striking in the fact that, here, the female flowers were seen at the ends of branchlets instead of short lateral branches (see photograph). On a closer examination, it was found that these abnormal inflorescences consisted of both male and female flowers in a 'catkin', the male flowers were lower and the 'catkin' terminated in female flowers. The groups of male and female flowers were normal and the female flowers in the 'catkins' were mostly fertilised with mature seeds.

It is interesting to note that such a condition of the inflorescence would suggest the possibility that in the case of the Casuarinales, one could expect shoots with staminate and pistillate 'catkin' inflorescences or shoots with androgynous 'catkin' inflorescences. Such a condition is indicated in the case of *Myrica gale* by Davey & Gibson (1917). Thus it is possible, from the structure of inflorescence, to

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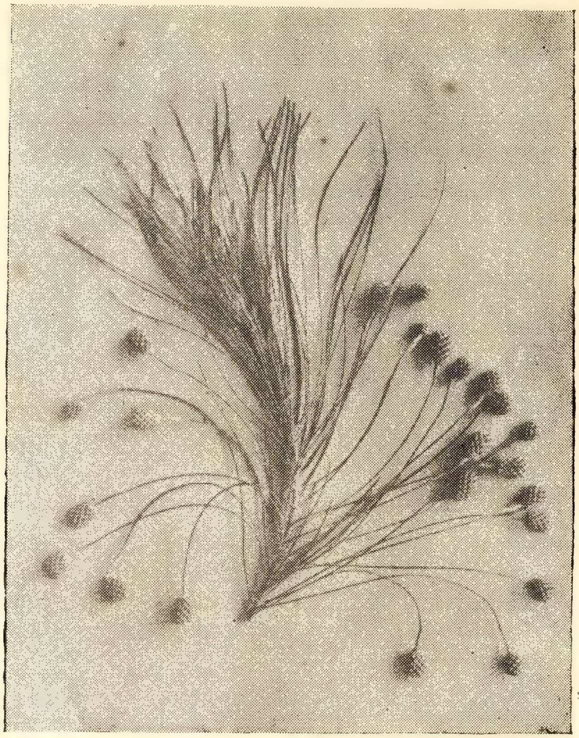
[1] Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station.



consider the Casuarinales as taking an early off-shoot in phylogeny from the Juglandales, rather than a separate line of evolution as indicated by Rendle (1956).

CENTRAL MARINE FISHERIES
RESEARCH STATION,
MARINE FISHERIES P.O.,
MANDAPAM CAMP, S. INDIA,
February 6, 1960.

P. PRASANNA VARMA

REFERENCES

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26. BAMBOO FRUITS

(*With two plates*)

A considerable amount of public interest was caused recently by the publication of a newspaper report that a large number of bamboo clumps in the Mizo Hills (formerly known as the Lushai Hills) of Assam are producing large numbers of peculiar fruit. The clumps later dried up and the whole area was infested by rats, which evidently came to consume the kernels of the fruit. Exaggerated reports also appeared in the press stating that rats had multiplied in large number and that many of the fruit were being sold in the market at a high price. The fruiting of bamboo being of very rare occurrence, it was considered by old villagers as an ill-omen, and as a fore-runner of famine in the country.

Similar reports of flowering of a bamboo, commonly called the *mooli* bamboo, came from North Bengal. Mr. R. I. Macalpine of the India Tea Association, Nagrakata, informed the author that a large plantation of bamboo in Ranicherra Tea Estate on the main road from Siliguri to Mal had flowered and fruited. In forest areas of Moraghat Range under the Jalpaiguri Forest Division, the *mooli* bamboo plantation at Rehti had also been reported to have flowered. It was further verbally reported by some forest officers that a few clumps of *mooli* bamboo near Bamanpokhri Reserve Forest, about twelve miles north-west of Siliguri, had also flowered.

It is, however, known that many species of bamboos are monocarpic, i.e. they produce flowers and fruit only once in their life-time, and that the plants die after the production of flowers and fruit. The flowering is simultaneous and takes place in almost all the clumps over a wide area. The *mooli* bamboo is botanically known as *Melocanna bambusoides* Trin., and is distributed over north Bengal, Assam, East Pakistan, and Burma. The bamboo is thin-walled but, in view of certain desirable qualities, it is considered an important bamboo for building purposes. According to Gamble (1896) about 16 million pieces of this bamboo used to be exported annually from East Pakistan to the Gangetic delta area for building purposes. The usual flowering cycle is 30 to 35 years but this requires further study and confirmation. The years of flowering as given by Gamble (1896), Brandis (1907), (1960) and C.C.F. (W.B.) are as follows:

(i) 1863-1866; (ii) 1892-1893; (iii) 1900-1902; (iv) 1933; (v) 1960 (the present flowering).

According to Pearson (1920), the *mooli* bamboo flowered over a large area in Cachar district of Assam during 1910-1912.

The flowering and fruiting of *mooli* bamboo is an interesting phenomenon as this bamboo is known to produce the largest size of fruit among bamboos. The only other genus of bamboo which produces conspicuous but smaller fruit is *Ochlandra*, which is commonly found in south India and Ceylon. In view of the rare phenomenon of flowering and fruiting of the *mooli* bamboo at intervals of 30 to 35 years, it was decided to visit the clumps at Bamanpokhri Forest. One visit was made by the author on 30th May 1960, in company with Mr. T. K. Mitra of West Bengal Forest Service and Mr. S. N. Singh Deo, M.L.A. Some fruit collected from the first visit were shown to Dr. M. M. Das, Deputy Minister, Government of India (Ministry of Scientific Research & Cultural Affairs), who happened to be in Darjeeling at that time. As Dr. Das took keen interest and expressed a desire to examine the fruiting clumps personally, a second visit to the spot was arranged on the 4th June 1960, and the author accompanied Dr. Das again to the spot in the forest.

It was indeed a wonderful sight for a botanist to see the bamboo clumps with large numbers of drooping fruit. As many botanists are not familiar with bamboos in fruit, the first impression was that the fruit belonged to some creepers which might have twined round the bamboos. On closer examination, however, this illusion vanished. The fruits are green or greenish yellow and apple- or pear-like in general appearance with a tapering and pointed end. Unlike the normal fruit of the grass family, the young fruit of this bamboo contain a liquid endosperm, while the endosperm in the mature fruit is fleshy with a cavity in the middle. Both the liquid and the fleshy endosperm are comparable with the liquid and the fleshy endosperm of green and ripe coconuts. The kernel in mature fruits is creamy-white, oval, and edible. A study of the development of the embryo of this bamboo and its nature and differences if any, from the normal embryo of other members of the grass family would be interesting.

It is rather unfortunate that these monocarpic bamboos die after the production of flowers and fruit. No detailed study regarding the causes (climatic, edaphic, florigenic, or genetic) of this flowering has been done, and it appears that such studies would be of great value. In our present state of knowledge the information, that the bamboo would flower at the end of its 30th or 35th year of life appears to be of some advantage. This bamboo is cultivated on plantation scale as it is an important source of paper pulp. In the first place, the extraction of the bamboo from the plantation may be so planned that the major part is extracted much ahead of the anticipated time

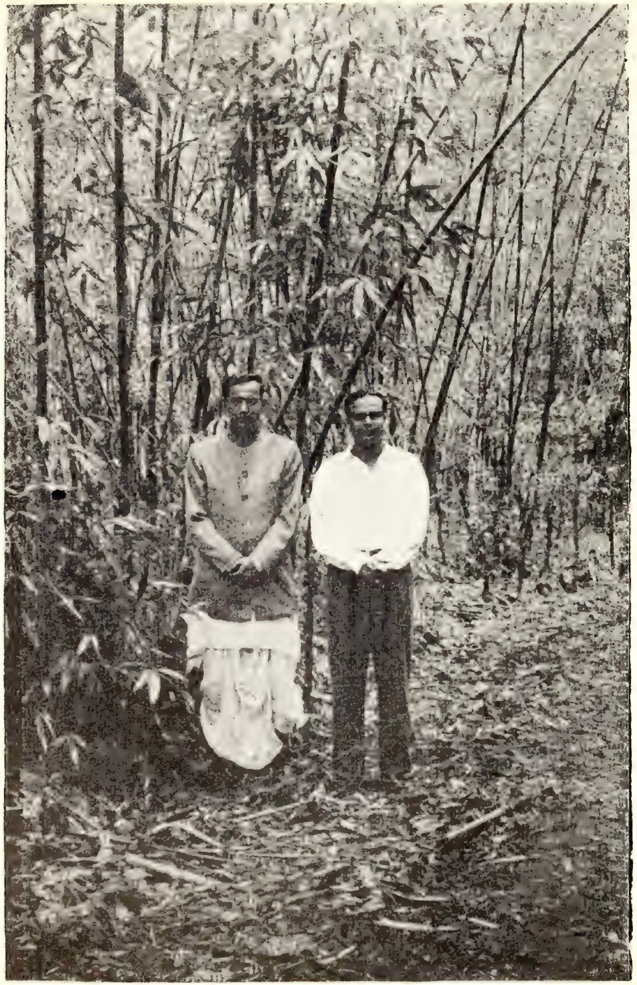

Fig. 1. Photo shows the general habit of *mooli* bamboo (*Melocanna bambusoides*). Standing in the foreground are Mr. S. N. Singh Deo, M.L.A. and Mr. T. K Mitra.

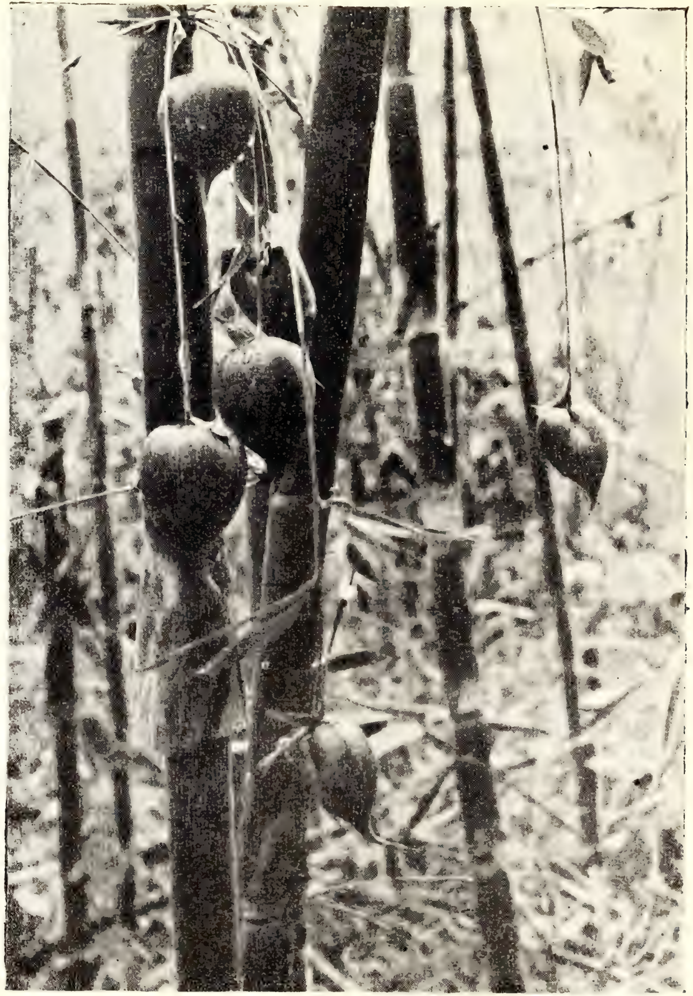

Fig. 2. Shows a cluster of fruits hanging from the bamboo culm

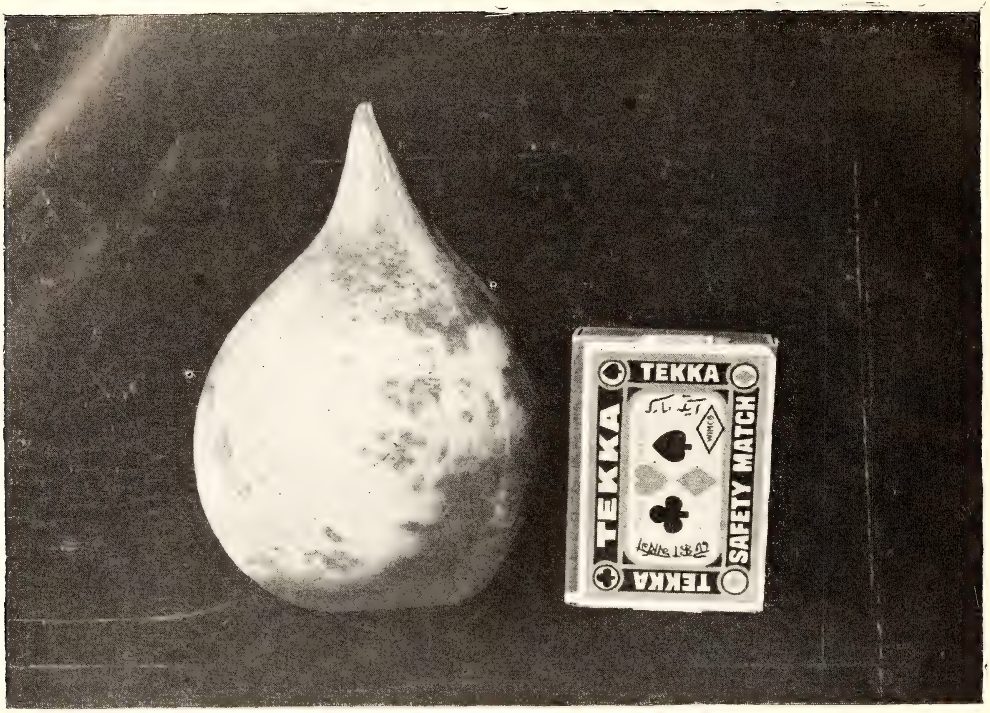
TEKKA
TEKKA
SAFETY MATCH
WIMCO
TEKKA

Fig. 3. A close view of a fruit taken along with a match box for comparison of size

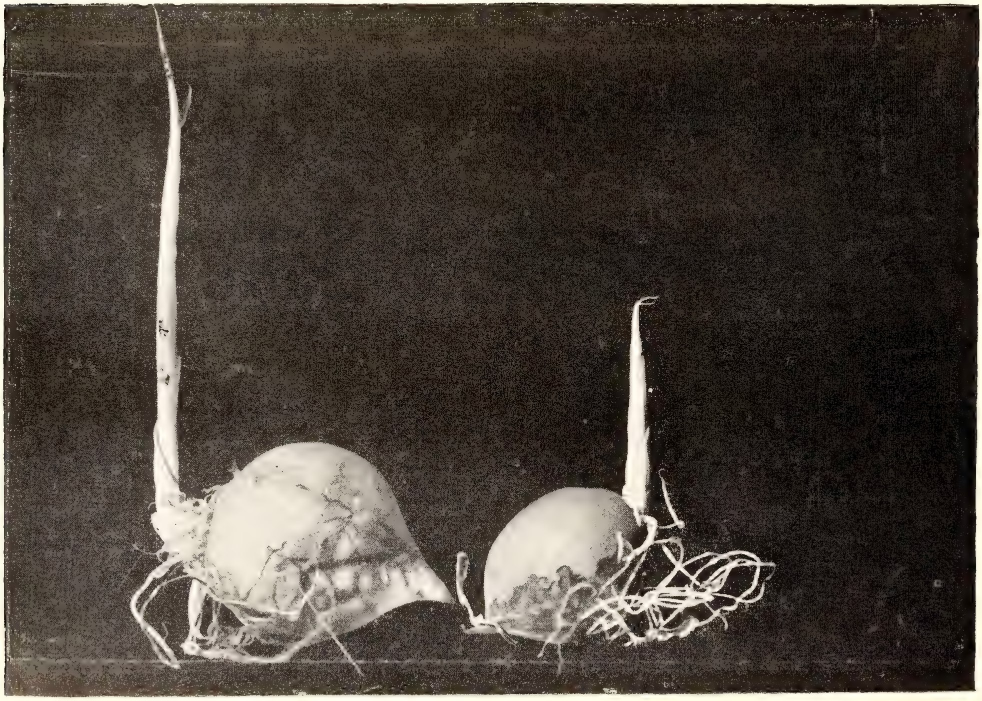

Fig. 4. Fruits showing germination of the young plant

of flowering and fruiting. In the second place, uniform growth would be assured when new plantations are planted by using the fruits as propagating material. Thirdly, due to the advantage of easy transport of these fruits, new plantations could be raised in distant places and even outside the country by transporting the fruits by air, if necessary.

On examination of the fruiting culms, it was found that the fruits hang with their pointed ends downwards and, with slight breeze or wind, the fruits drop and the pointed ends strike the soft and moist soil first and thus fix the fruits to the ground. The atmosphere at the time of fruit drop being highly humid, it was noticed that all the fruits germinated simultaneously. The germination was so quick that it was even suspected that some fruits must have germinated while still on the tree. On careful examination, however, no viviparous fruits were noticed but the occurrence of this phenomenon cannot be altogether ruled out as stated by Gamble.

I have not been able to locate any good published photograph of this bamboo in fruit. The drawings given by Gamble (1896) and Brandis (1907) do not convey a clear idea of the manner in which the fruits are held on the culm. Only one photograph of the sterile bamboo clumps has been published earlier by Pearson (1920). A number of photographs of the fruiting culms, fruits, and germinating fruits were taken on the spot by the author. Some of these photographs, probably the first few, showing clearly the fruits hanging on actual growing plants, are published along with this note.

INDIAN BOTANIC GARDEN,
BOTANIC GARDEN P. O.,
CALCUTTA,
July 6, 1960.

D. CHATTERJEE

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27. NEW SPECIES OF CYANOPHYCEAE FROM MYSORE STATE—I

(*With two plates*)

In this paper three new species of the Cyanophyceae, one of *Calothrix* and two of *Cylindrospermum*, are described. These have been collected from areas which, prior to the reorganization of the States, were included in Bombay State, and now come within Mysore State.

1. **Calothrix santapaui**[1] sp. nov. (Plate 1, Figs. 1 and 2)

Filaments single, straight or curved, sometimes branched. Sheath firm, hyaline to yellow-brown, distinctly stratified ; in the basal region 20-25 μ broad ; in the middle of the filament tumid and 30-40 μ broad ; basal part of the filament surrounded by a thick layer of refractive mucilage. Trichomes without constrictions at joints and tapering into a long hair which comes out of the sheath at right angles to it in the upper part of the filament. Cells shorter than broad or as long as broad ; in the basal portion, 5.1-6.4 μ broad, 3.2-6.4 μ long; long cylindrical in the region of the hair and 2 μ broad. Heterocysts basal, single, spherical to ellipsoidal, 5.8-6.4 μ broad, 5.8-7.2 μ long. Akinetes one to three in a row, separated by disintegrated cells, cylindrical, 6.4-9.7 μ broad, 12-24 μ long ; outer wall of the akinetes smooth and hyaline.

In a mucilaginous mass with other algae at Castle Rock on 2nd November 1951. Collected by N. D. Kamat and kept in the personal collection of the senior author. No. M 15.

Filamenta singula, recta vel curvata, nonnumquam ramosa vel furcata. Vagina firma, hyalina vel luteo-brunnea, distincte stratis diversis notata, in regione basali 20-25 μ lata, ad medium tumescens 30-40 μ ; filamenti basis circumdata corio denso mucilaginoso refractivo. Trichomata non constricta ad septa, fastigata in appendicem longam, quae ad partes superiores filamenti emergit e vagina efformans angulum rectum. Cellulae longitudine minores quam latitudine vel aeque longae ac latae ; cellulae basales 5.1-6.4 μ latae, 3.2-6.4 μ longae, in regione appendicis elongato-cylindricae, 2 μ latae. Heterocysta basalia, singula, sphaerica vel ellipsoidea, 5.8-6.4 μ lata, 5.8-7.2 μ longa. Akinetes 1-3 in serie, separati inter se cellulis corruptis, cylindrici, 6.4-9.7 μ lati, 12-24 μ longi, parietibus exterioribus levibus et hyalinis.

Typus lectus in massa mucilaginosa algarum ad Castle Rock a N. D. Kamat die 2 novembris anni 1951 et positus in herbario auctoris senioris sub numero M. 15.

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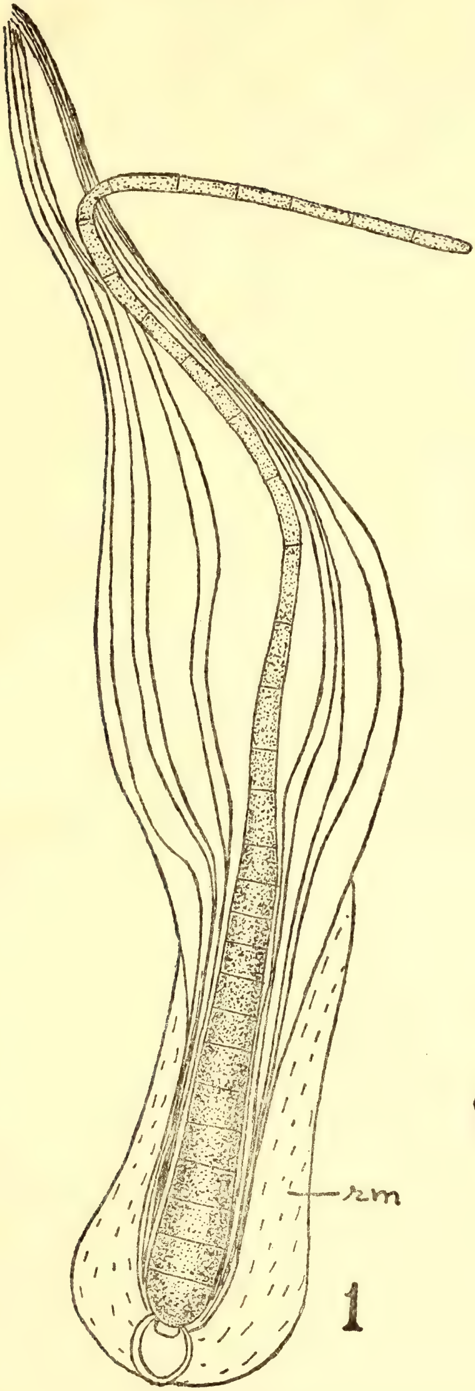
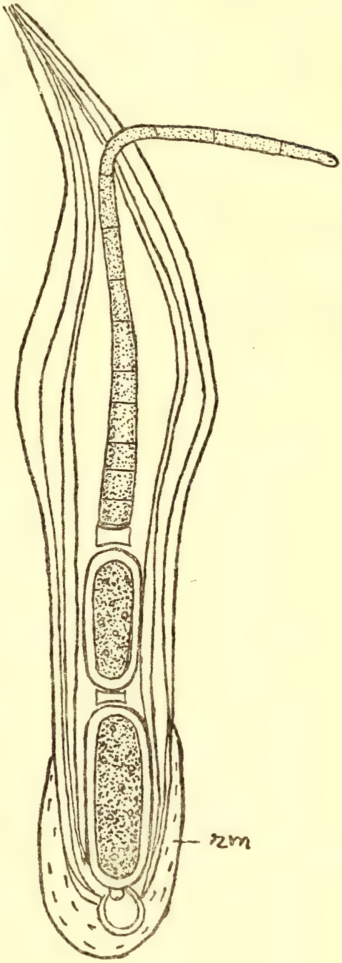
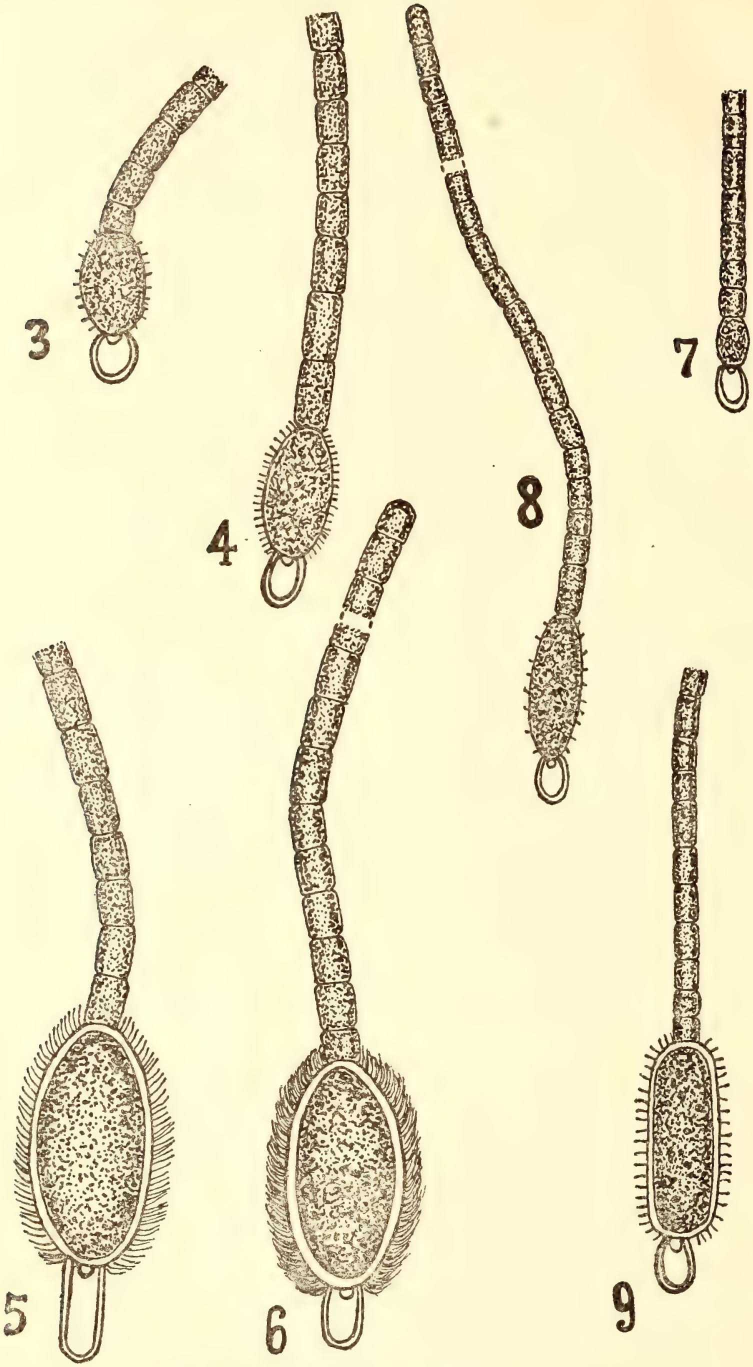
[1] Named after Rev. Fr. H. Santapau, the well-known botanist of India.





Figs. 1 and 2. *Calothrix santapaui* sp. nov.
rm—refractive mucilage
Figs. 1 and 2. × 1280



Figs. 3-6. *Cylindrospermum gracile* sp. nov.
Figs. 7-9. *Cylindrospermum echinulatum* sp. nov.
All figs. × 1280

The only species with which this species agrees in respect of the stratified sheath, cylindrical akinetes, and unconstricted cells is *C. sandwicensis* (Nordst.) Schmidle (Geitler, 1932) ; but its cells and akinetes are much longer than those of *C. sandwicensis*, while the tumid sheath in the middle of the filament makes it distinctive. The akinetes in this alga may be one to three. When more than one, they occur in a series alternating with dead cells.

2. **Cylindrospermum gracile** sp. nov. (Plate 2, Figs. 3-6)

Plant-mass mucilaginous, blue-green. Trichomes loosely entangled, with constrictions at the joints. Cells cylindrical, rarely quadrate, 3.2-3.8 μ in diameter, 3.8-6.4 μ long. Heterocysts ellipsoidal, rarely cylindrical, 3.8-5 μ in diameter, 5-12.3 μ long. Akinetes single, ellipsoidal, 12.5-15 μ in diameter, 20-30 μ long, with fine, hair-like processes, 3.2-4.5 μ long.

Attached to blades of grass in a small pond at Devarayi on 15th October 1951. Collected by N. D. Kamat and kept in the personal collection of the senior author. No. M 16.

Plantae massa mucilaginosa, caeruleo-viridis. Trichomata laxe intertexta, constricta ad septa. Cellulae cylindricae, raro quadratae, 3.2-3.8 μ diam., 3.8-6.4 μ longae. Heterocysta ellipsoidea, raro cylindrica, 3.8-5 μ diam., 5-12.3 μ longa. Akinetes singuli, ellipsoidei, 12.5-15 μ diam., 20-30 μ longi, ornati processibus tenuibus capilli similibus 3.2-4.5 μ longis.

Typus lectus affixus foliorum laminis graminum in lacuna parva ad Devarayi die 15 octobris anni 1951 a N. D. Kamat, et positus in herbario auctoris senioris sub numero M. 16.

This species is distinguished from all the known species of *Cylindrospermum* by the hair-like processes on its akinetes.

3. **Cylindrospermum echinulatum** sp. nov. (Plate 2, Figs. 7-9)

Plant-mass mucilaginous, light blue-green. Trichomes loosely entangled, with constrictions at the joints. Cells quadrate to cylindrical, 2.5-2.8 (-3.2) μ in diameter, 3.2-5.2 μ long. Heterocysts ellipsoidal, rarely quadrate, 3.2-4.5 μ in diameter, 5-7.7 μ long, mostly present at both ends of the trichomes. Akinetes single, cylindrical, 9-11 μ in diameter, 16-22 μ long, outer wall yellow-brown, ornamented with fine slightly curved spines, 1.5-2.5 μ long.

Free-floating in a puddle at Londa on 14th March 1952. Collected by N. D. Kamat and kept in the personal collection of the senior author. No. M 17.

Plantae massa mucilaginosa, pallide caeruleo-viridis. Trichomata laxe intertexta, constricta ad septa. Cellulae quadratae vel cylindricae, diametientes 2.5-2.8 (-3.2) μ, 3.2-5.2 μ longae. Heterocysta ellipsoidea, raro quadrata, 3.2-4.5 μ diam., 5-7.7 μ longa, ut plurimum insidentia utrique apici trichomatum. Akinetes singuli, cylindrici, diametientes 9-11 μ, 16-22 μ longi, parietibus exterioribus luteo-brunneis, ornati spinis sparse curvatis 1.5-2.5 μ longis.

Typus lectus libere natans in lacuna ad Londa die 14 martii anni 1952, a N. D. Kamat et positus in herbario auctoris senioris sub numero M 17.

This alga resembles *Cylindrospermum trichotospermum* Fremy (Geitler, 1932) and *Cylindrospermum gorakhporense* Singh (Singh, 1939) in possessing delicate needle-shaped projections, but the akinetes here are cylindrical and not ellipsoidal as in *Cylindrospermum trichotospermum* and *Cylindrospermum gorakhporense.* Moreover this is a much smaller form.

ACKNOWLEDGEMENT

The authors sincerely thank Rev. Fr. H. Santapau for rendering into Latin the diagnoses of the new types.

INSTITUTE OF SCIENCE,
BOMBAY, 1,
February 12, 1960.

ELLA A. GONSALVES,
N. D. KAMAT.

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28. *CORYNOMORPHA PRISMATICA* J. AG. FROM OKHA: A NEW LOCALITY RECORD FOR INDIA

(*With two plates*)

The genus *Corynomorpha,* till recently recognised under the family Grateloupiaceae in Cryptonemiales, consisted of but two species of little known red algae, viz. *Corynomorpha prismatica* J. Ag. and *C. clavata* Harvey. Balakrishnan (1958, 1959), however, created a new family Corynomorphaceae with a single genus, *Corynomorpha,* and with type species *C. prismatica,* based on the nature of the reproductive structures in the alga which were found by him to be variant from those met generally in Cryptonemiales.

The species *C. prismatica* (*Acrotylus prismaticus* J. Ag.) was earlier known from the coast of Hindustan, S. India (Agardh, 1851, p. 193). It was also reported by Boergesen (1937) from Cape

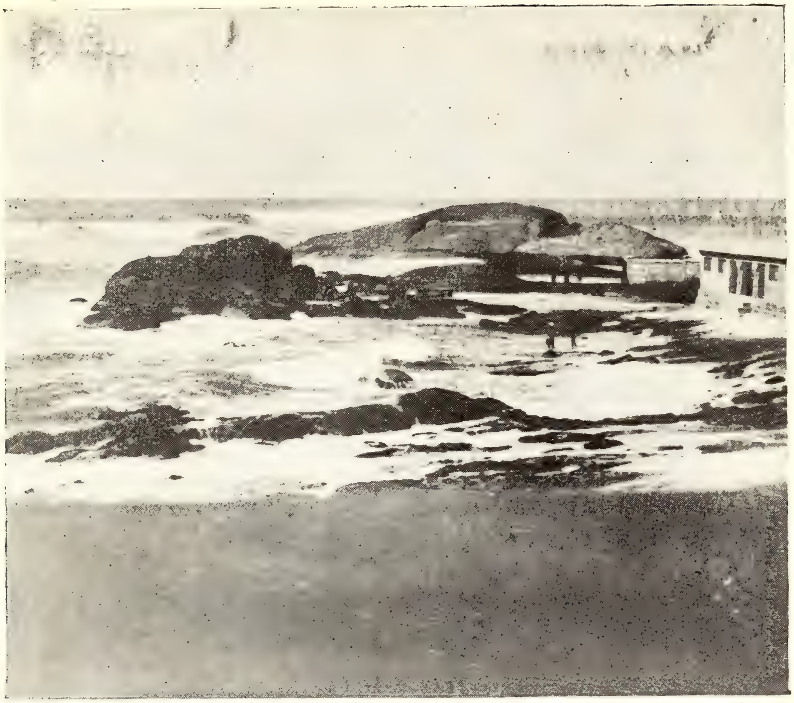

Fig. 1. General aspect of the Rocky Coast at Cape Comorin, S. India

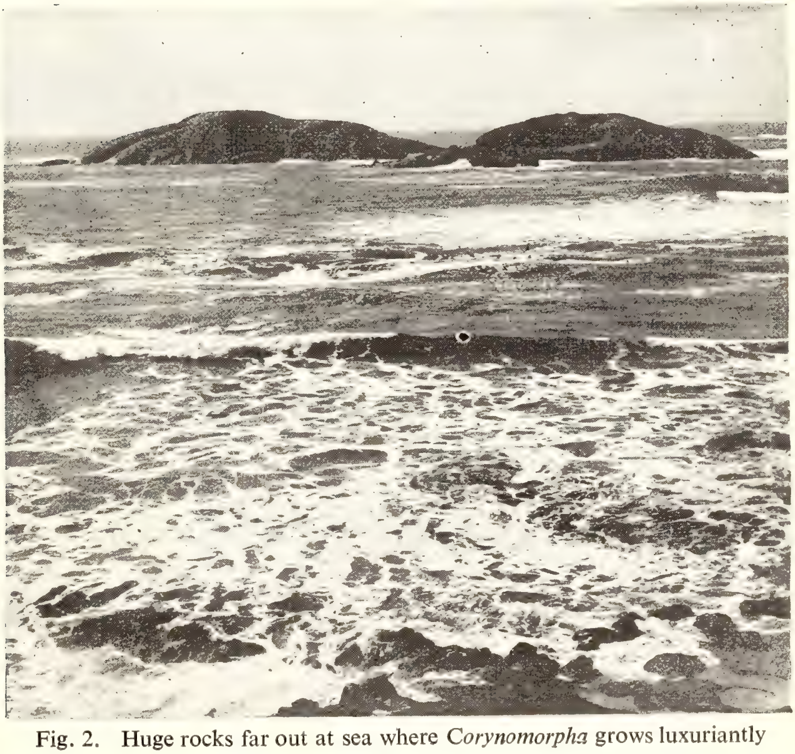

Fig. 2. Huge rocks far out at sea where *Corynomorpha* grows luxuriantly

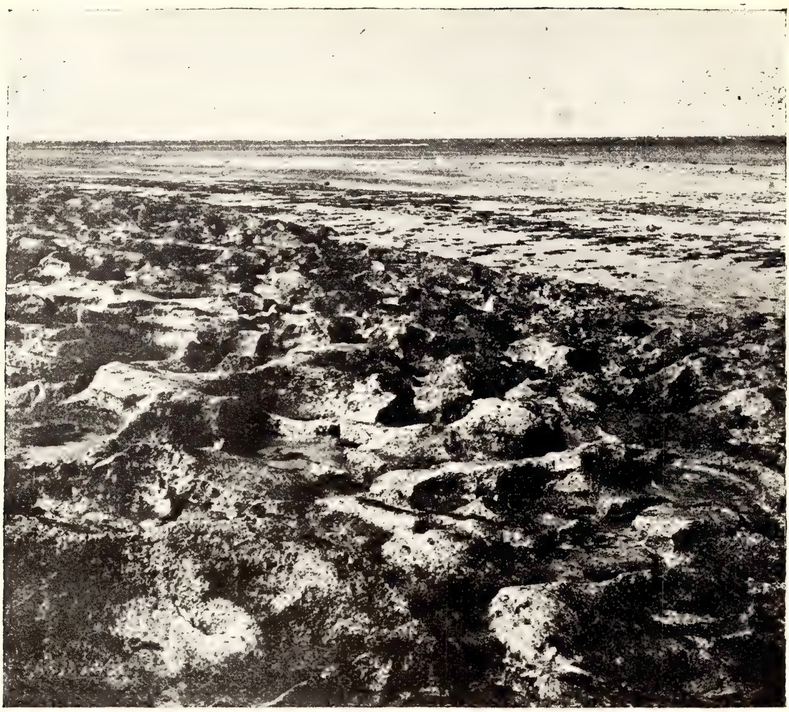

Fig. 3. General aspect of the coast at Okha

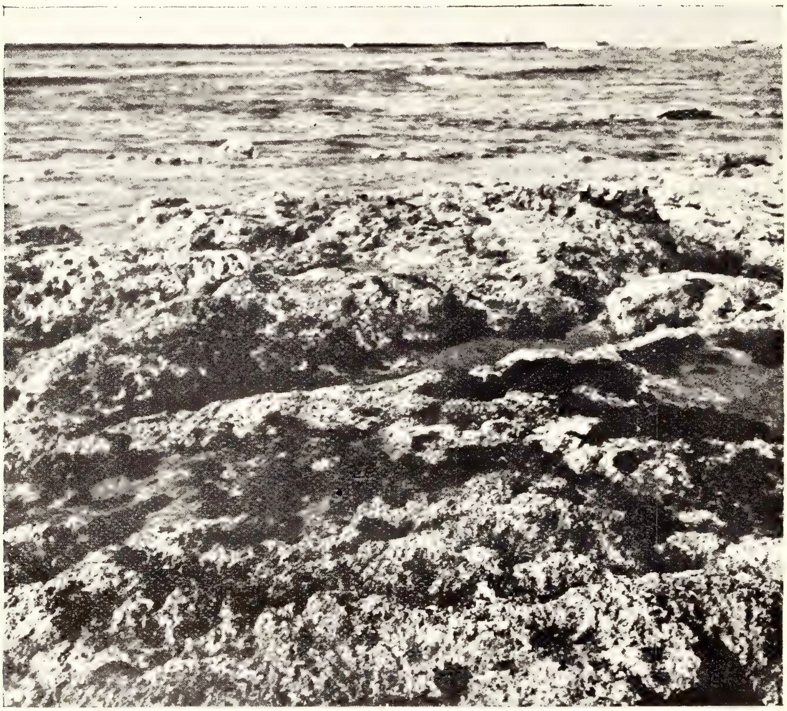

Fig. 4. Rock-pools and channels in the inter-tidal regions, at the sides of some of which *Corynomorpha* flourishes

Comorin in south India, on materials collected by Prof. Iyengar from that area. The author has collected this alga quite frequently from Cape Comorin with Prof. Iyengar or independently. At Cape Comorin, it grows attached to some of the huge Archean-gneiss rocks in the open sea which are exposed to direct and violent surf-action (Figs. 1, 2). The alga is generally at the sides of submerged portions of rocks well below the surface level of the water. In these areas, a sort of a vertical zonation of algal growth can be noticed. At comparatively higher levels *Caulerpa racemosa* (Forsk.) W.v.B. and *C. peltata* Lamour are seen. Below this, *Botryocladia leptopoda* (J. Ag.) Kylin comes up; further below *Corynomorpha prismatica* is found marking perhaps the lowest limit of algal growth in these vertical series. Below the *C. prismatica* level usually it is either barren or colonised by a few animal communities.

At Cape Comorin *C. prismatica* is at its best and most luxuriant growth at the sides of a huge rock seen far out at sea (Fig. 2). This rock can be reached by means of country catamarans, though with some difficulty and with a certain amount of risk. From the writer's personal experiences and observations, this rock shows extensive growths of *C. prismatica*; the plants themselves are more tough, sturdy, and deeper in colour and larger than those found elsewhere nearer shore. The alga is invariably found heavily loaded with the epiphytic red-alga *Leveillea jungermannioides* (Mert et Hering) Harv.

Apart from the locality mentioned above, the writer has collected *C. prismatica* from Okha Port in Saurashtra, in the northern part of the Arabian Sea. From this area, it is reported here for the first time. In this locality, the alga was, however, found in quite a different situation from that met with at Cape Comorin. The alga grew luxuriantly at the inter-tidal belt, and well above the low-water mark. Here the coast is gently sloping towards the sea and more or less flat with undulations of the hard rocky substrata composed of Deccan Traps and Tertiary formations (Figs. 3, 4). This area is further characterised by long and narrow crevices with very shallow channels and rock-pools, which are heavily silted by very fine smooth white sand and mud. At low tide, the entire area becomes exposed, with absolutely calm rock-pools and narrow channels with about a foot or a little more of clear water in them. At the sides and on the vertical faces of such pools and narrow channels, *Corynomorpha prismatica* was found well above the water level, but sufficiently protected from direct insolation; it was associated with *Caulerpa scalpelliformis* (R. Br.) W.v.B. and *C. peltata*. Compared to the Cape Comorin alga, the Okha form was less robust and lighter in colour, being purple-red with a tinge of yellowish brown.

INDUSTRIAL SECTION,
INDIAN MUSEUM,
CALCUTTA,
February 23, 1960.

K. S. SRINIVASAN,
Curator.

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29. OBSERVATIONS ON SOME DRIFT ALGAE AT MAHABALIPURAM COAST

(*With three plates*)

The present account is based on observations and collections made in the field by the author at Mahabalipuram coast, about 56 km. south of Madras, during a study of the ecology and seasonal succession of the marine algae of the locality covering a period from October 1944 to September 1945.

Reports on algal drifts on Indian coasts are extremely few, although some records are seen wherein a particular species of alga is mentioned as having been collected from a locality to which it would appear to be alien. Edgar Thurston collected *Sphacelaria tribuloides* Menegh. growing on an old battered and indeterminable stem of a fucaceous plant cast ashore on the beach at Madras (Boergesen 1938: 209). From the same locality he collected *Halymenia dilatata* Zan. (Boergesen 1938: 214) and *Avrainvillea erecta* (Berkeley) A. & E. S. Gepp (Gepp 1911: 29). Rangachary collected from the same beach *Scinaia bengalica* Boergs. (Boergesen 1938: 209). Grunow (1915, 1916) has referred to some species of *Sargassum* from Tranquebar in south India, based on the collections made by Koenig and Klein and on the materials present in the herbaria of Rottler and Rudolph. Krishnamurthy (1954: 176) has, however,

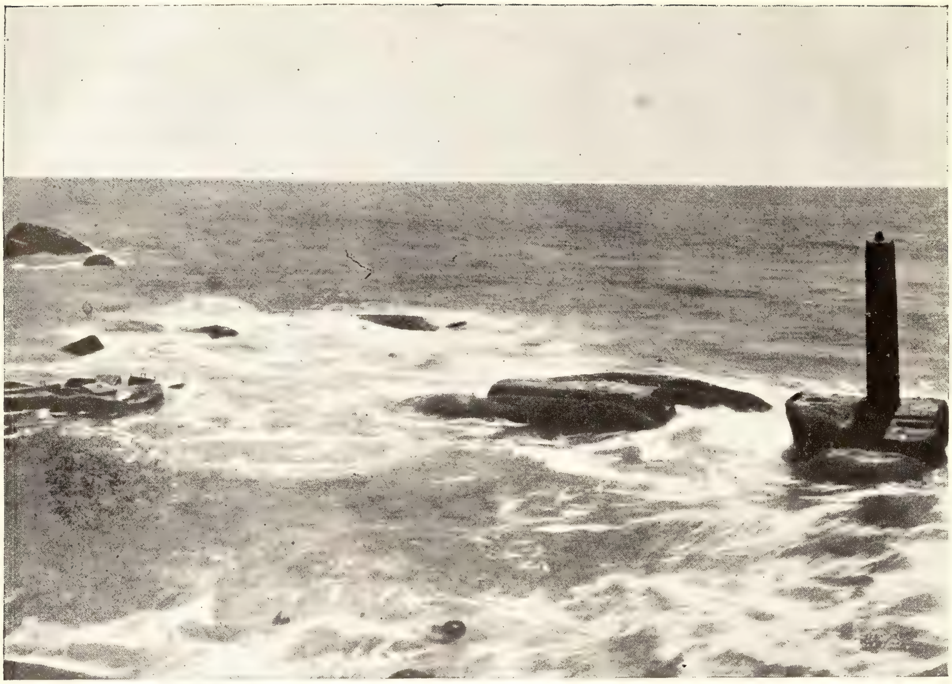


Fig. 1. Photograph showing naturally occurring rocks in the sea, opposite the Shore-Temple

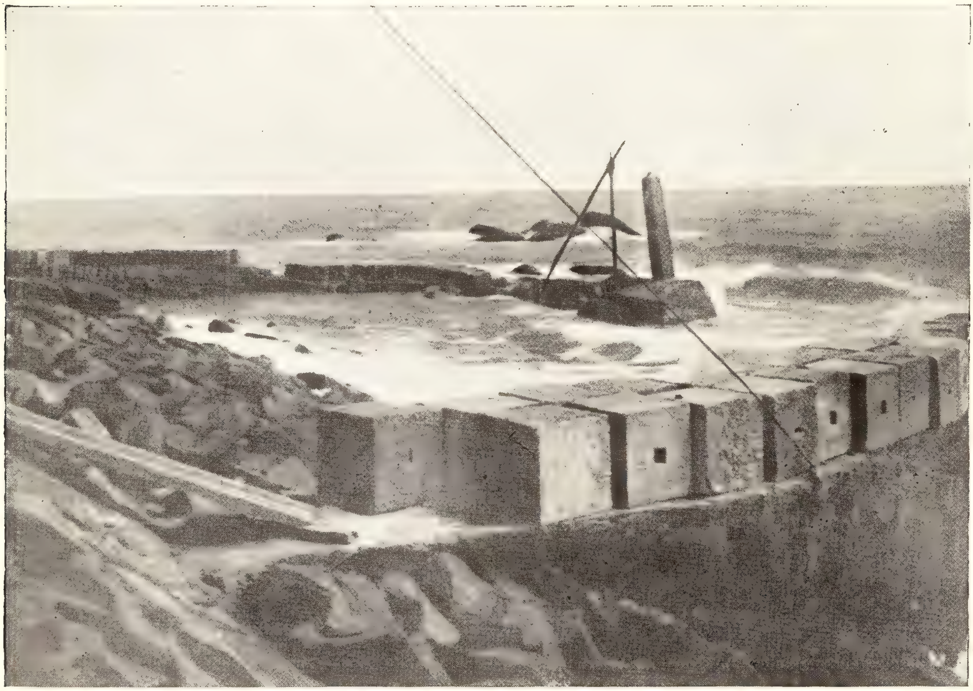


Fig. 2. Groyne-wall in front of Shore-Temple

Photos: By courtesy of the Archaeological Survey of India, S. Circle referred to some marine algae as *Sargassum*, *Turbinaria*, *Hormophysa* and *Ulva reticulata* from Pamban and Tuticorin, being stranded at the Madras beach in the salt marshes at the mouth of River Adyar. A careful examination of the coasts from where the algae mentioned above have been collected would readily show that the particular habitat associated with these algae is not present at these coasts. In fact, these algae do not grow in the localities referred to.

The greater part of the coast at Mahabalipuram is sandy. In the immediate vicinity of the Shore-Temple and opposite to it, a few rocks are seen, some of which are quite large and project a little into the sea (Fig. 1). To protect the Shore-Temple from sea erosion, huge boulders are piled up to some distance from and on either side of the Shore-Temple. In front, a sea-groyne is also constructed (Fig. 2) to ensure additional protection. The natural rocks, the artificial groyne-wall, and the embankments of large boulders afford very good substrata for a variety of algae to grow and flourish on this coast and at various seasons of the year.

Even though the coast harbours a number of marine algae, the forms which are cast ashore at different seasons are very few and practically insignificant. Among the plants of the coast that may be seen stranded at different times may be mentioned species of *Ulva*, *Enteromorpha*, *Cladophora*, *Chaetomorpha antennina* (Bory) Kutz. [=*Chaetomorpha media* (Ag.) Kutz.] and *Grateloupia filicina* (Wulf.) Ag.

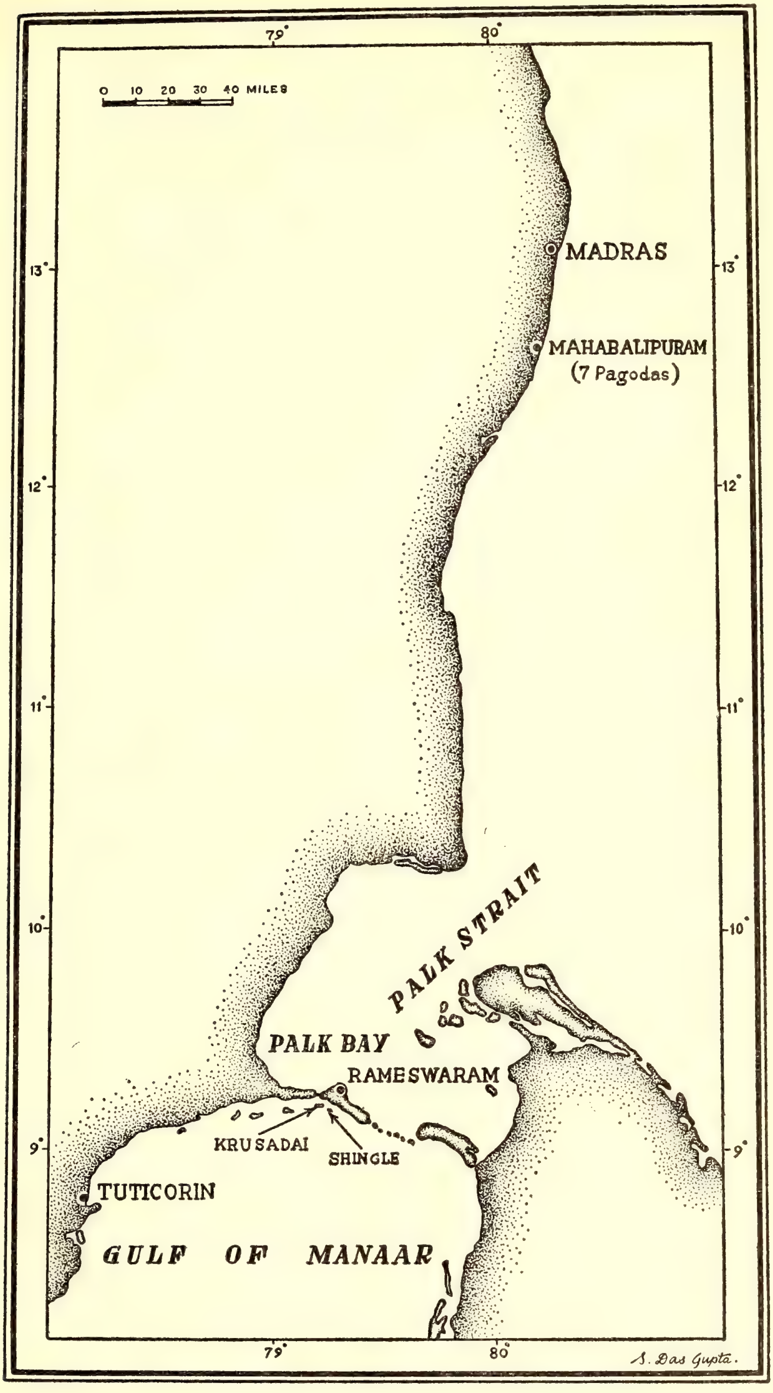
Apart from the species mentioned above, during the early part of October 1944, the author made a good collection of various other species from the beach at Mahabalipuram, Edayur, (another sea-shore village south of Mahabalipuram), and beyond, the stretch of coast thus extending a little over 8 km. (5 miles). For the most part, the coast along this beach is practically sandy. At Edayur a few rocks are seen, but the algal vegetation on them was extremely poor, with only a few forms of Chlorophyceae as *Ulva*, *Enteromorpha*, and *Chaetomorpha*.

The collection of algae stranded at the Mahabalipuram coast comprised several bits of brown sea-weeds as *Sargassum* (at least about three species), *Turbinaria*, *Cystophyllum muricatum* (Turn.) J. Ag., *Hormophysa triquetra* (L.) Kutz., a single specimen of this very rare alga attached to a coralline fragment, and *Hypnea musiformis* (Wulf.) Lamour attached to *Turbinaria*. Besides these sea-weeds, and entwined by *Sargassum* clumps, a few specimens of the hypocotyl of *Rhizophora mucronata* Lam. and *Ceriops candolleana* Arn. were also collected from the beach. In some places the algae were found thrown up high on the shore to a distance of 9 to 12 metres from the water's edge at low tide. In some cases, the specimens were found lying on the beach completely exposed and, in other cases, partially or completely buried under tiny sand mounds formed through wind action. Most of the specimens were found in quite fresh condition.

It was, however, in the month of October 1944 that comparatively more numerous specimens were found stranded on the shore. In November, the number was much less and only stray bits of two or three species of *Sargassum* and a few bits of *Cystophyllum muricatum* and *Turbinaria* were found, this time all the stranded specimens occurring on the beach north of Shore-Temple. In December, however, the number was at its lowest, with only two or three bits of *Sargassum* and a single bit of *Turbinaria,* even though the sea was very rough, and there was heavy rain for a number of days continuously, conditions which can be regarded as favourable for many algae to get stranded. In the months following December, none of the species mentioned above was found stranded on the beach.

It is significant to mention here that species of *Sargassum, Turbinaria, Cystophyllum, Hormophysa, Rhizophora,* and *Ceriops* do not at all grow at Mahabalipuram or in the neighbouring areas. These specimens, therefore, must possibly have come from a distant shore. The nearest possible source would appear to be Krusadai and the neighbouring islands in the Gulf of Manaar, which islands lie, as the crow flies, about 400 km. (250 miles) south of Mahabalipuram (Fig. 3). The following evidence would seem to lend much support to this view:

1. The species of *Sargassum, Cystophyllum, Turbinaria,* and *Hormophysa* collected at Mahabalipuram coast have their representatives flourishing well at Krusadai and the neighbouring islands at the reef and in the lagoons.
2. The coral bit to which *Hormophysa* was found attached would lend support to the origin of these algae from a coralline region which is met with at Krusadai and other islands in the Gulf of Manaar.
3. *Hormophysa triquetra,* which is an extremely rare alga of our country, is seen only at the Krusadai Island along the Bay of Bengal coast, even though coralline substrata and lagoons, which form the characteristic habitat of this alga, are found in other neighbouring places and islands in the Gulf of Manaar, off Tuticorin coast.
4. The hypocotyl specimens of *Rhizophora* and *Ceriops* would further confirm that all these specimens must have come from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PALK BAY
RAMESWARAM
KRUSADAI
SHINGLE
TUTICORIN
GULF OF MANAAR
S. Das Gupta.

Fig. 3. Map showing Krusadai and other islands and Mahabalipuram

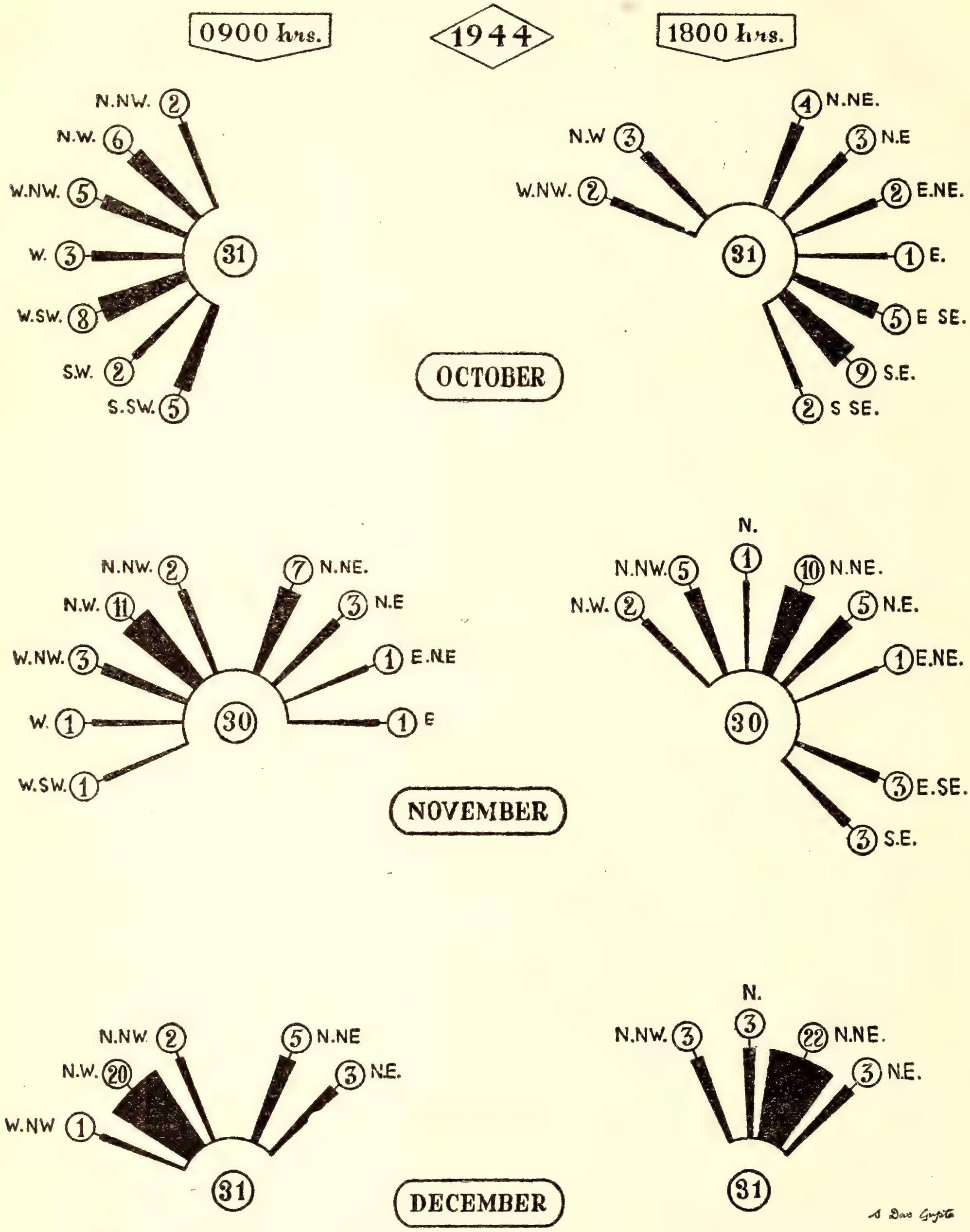

Fig. 4. Diagram showing wind directions and frequencies during October-December 1944

Krusadai Island, where in the region of coral islands in the Gulf of Manaar these mangroves are found.

The ocean currents and the direction of wind (Fig. 4) would seem to have contributed much towards the drift of these algae and other specimens from Krusadai in the Gulf of Manaar, ultimately casting a portion of them on the Mahabalipuram coast. It would be very interesting to know the extent of such drifts along our coasts and to what distant shores the plant materials are carried by Nature's processes.

In the light of the evidence now before us, the collections made by Thurston, Rangachary, and others from Madras (Boergesen 1938; Gepp 1911) and Tranquebar (Grunow 1915, 1916) would be intelligible. The genus *Avrainvillea*, a rare green-alga of our coasts, inhabits shallow lagoons and intertidal belts with coralline and mud substrata. It is found at the coralline beds at Krusadai and Hare Islands in the Gulf of Manaar. Similarly *Scinaia bengalica* is found growing on coral rocks at the reefs at Krusadai and the neighbouring areas. These species must, therefore, have come from these localities and been cast on the Madras beach. As regards the several species of *Sargassum* reported by Grunow from Tranquebar, it may be stated that Tranquebar with a purely sandy coast does not show any situation at all favourable for the growth of these forms. They, also, must have come from some distant shore and been stranded at Tranquebar beach.

ACKNOWLEDGEMENTS

Grateful acknowledgements are due to Rev. Fr. H. Santapau, S.J., for his kind criticism and help in the preparation of this paper.

INDUSTRIAL SECTION,
INDIAN MUSEUM,
CALCUTTA,
March 10, 1960.

K. S. SRINIVASAN,
Curator

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Gleanings

A Female Mowgli?

The following extract from TIGER LADY: Adventures in the Indian Jungle, by Olive Smythies, published by William Heinemann Ltd., London (1953), is reproduced with the permission of the author and publishers:

Page 21: 'One day my husband came into the bungalow looking very excited. It appeared that a Forest guard had brought in a girl, about eleven years old, who had been found in a not very distant forest where she had been actually brought up by a bear—a sort of female Mowgli, who had lived as an animal all her life! The bear had been killed by villagers, who had seen this strange being wandering about near by. They had promptly captured and found to their astonishment that it was a human being, a girl. She walked on all fours and grunted like a bear. She was very savage, too, snapping and snarling at anyone who came near her. "She's been taken to the hospital, where she'll be fed on fruits and roots and carefully looked after", Evelyn told me. "I doubt if it will do any good, though."

'He was right. We often went too see her, and tried to make friends, but it was no use. She never became any tamer, and after a few months she pined away and died. This was the only authentic case of a jungle child I ever heard of in all my years in India.'

[The author informs us that this was some time between 1913-1916 and the child was kept at the Ramsay Hospital, Naini Tal.—EDS.]

Notes and News

SEVENTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE

The Seventh Commonwealth Entomological Conference was held in London from 6 to 15 July 1960. Nearly 50 delegates from most of the countries of the Commonwealth attended. India was represented by Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, who also presided over one of the sessions, on 'Recent investigations on timber boring beetles'.

The subjects discussed at the Conference were as follows: (i) Recent developments in insecticides for crop protection, (ii) Problems in the use of insecticides, (iii) Hazards and precautions associated with the use of pesticides, (iv) Research on stored products pests and their control, (v) Biological control of insects and weeds, (vi) Insect attack in relation to the physical characters and physiological state of the plant, (vii) Recent investigations on timber-boring beetles, (viii) Termite control in afforestation projects and constructional timbers, (ix) The utilization of pathogenic organisms in the control of insect pests, (x) Recent advances and current trends in the study and control of tsetse flies and trypanosomiasis, (xi) Developments in the study and dispersal of insecticides, (xii) Recent research on locusts and their control, (xiii) Developments in the study of plant viruses and their vectors and their bearing on control measures, and (xiv) The link between research work and its application in the field of plant protection.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—24-10-1960. C4378
EDITORS: H. SANTAPAU & HUMAYUN ABDULALI

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Vol. 57, No. 3

Editors
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JOURNAL
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1960 DECEMBER Vol. 57 No. 3

A Visit to the Flamingos in the Great Rann of Kutch

BY
SHIVRAJKUMAR OF JASDAN,
R. M. NAIK, PH.D.,
AND
K. S. LAVKUMAR OF JASDAN

(*With three plates*)

On **16 April 1960** the three of us and P. W. Soman of the Bombay Natural History Society assembled in the Modern Hotel at Bhuj. 'A sight for the Gods' Dr. Sálim Ali had written to us describing Flamingo City which he had visited on 21 March 1960 from the bird-ringing camp at Kuar Bet and, excited by what he said, we were about to set off hoping to share in the pleasure and to seize the privileged opportunity of witnessing the spectacle. However there was deep down amidst all the enthusiasm, a mild doubt which was ever so lightly perceptible in all our minds. Had not McCann said that the Rann dries up pretty fast when it does start doing so? He had found that the water receded many miles each day, forcing the breeding flamingos to evacuate their nests, some even containing hard-set eggs and newly hatched young, while countless chicks in the running stage fall out by the wayside unable to keep up with the rapidly retreating waters and lie as mute testimony to the disasters which strike breeding populations in nature. Suppose, we asked each other, that such a catastrophe had happened? Would we merely be witnesses to one of Nature's cruel acts of profligacy? Another alternative, the voice of doubt softly whispered: 'What if the birds have hatched out their eggs and taken their broods into deeper water?'

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However, these unpleasant thoughts were not allowed to choke our enthusiasm, for the bus seats for Khavda had to be reserved for the next morning, essential stores had to be purchased, and as a couple of us discovered that we lacked sunglasses to protect our eyes against the glare of the Rann we had to set about acquiring these. We therefore spent a busy afternoon in the picturesque and tortuous bazaars of Bhuj behind the thick medieval walls.

17 April 1960. The following morning we left for Khavda. The bus, a new one, was not over-crowded as most State Transport buses are. We had front seats, and the morning was pleasantly cool with a fresh breeze coming from the north. We travelled fast and soon the sandstone hills of Kutch were left behind, and the level country of the Banni's edge began. At first there were dense shrubberies of *Salvadora* and tamarisk which later thinned out and gave way to the flat featureless expanse of the true Banni. The Grey Partridge was plentiful and scuttled into cover, Common Babblers chattered among the shrubberies, and chattering flocks of Rosy Pastors migrating northward flew overhead. Redvented Bulbuls were common and White-eared Bulbuls were seen in increasing numbers. The latter seem to be very partial to *Salvadora*, and it is worthy of note that in near-by Saurashtra this pretty little bulbul is totally absent from large tracts of the interior, and is found chiefly around the coastal flats where the *Salvadora* also appears. Can it be merely a coincidence that the requirements of the bird and the plant are similar, or does the plant have an ecological influence on the bird?[1]

The Banni itself is a flat featureless expanse, a limitless plain of blue-green vegetation. The plants are short bushes with highly xerophytic characters; their fleshy leaves store large amounts of water, and are avidly cropped by camels. The Banni is a remarkable phenomenon; the plain lies but a few feet above sea-level, and is so lacking in gradient that the rain-water lies in a shallow sheet over it slowly draining into the sea, or just evaporating into the dry air. The disappearance of the water is followed by a parching dessication during the hot season, and the soil is encrusted by salt; tall dust devils race across the expanses and mirages shimmer, tantalising and cool, in every direction. This is stock-rearing country, famous for its fine herds of large-horned cattle and camels.

For the first time the large Franklin's Crested Lark appeared, several female Pale Harriers and a Marsh Harrier went gliding north, hunting as they went. We were all on the look-out for the splendid Desert Larks but saw none; instead, we saw a few Redwinged Bush Larks in patches of grass and *Prosopis*, and isolated pairs of Ashycrowned Finch Larks feeding beside the road. Some of the trenches on both sides of the road still contained watery mud choked with frogs and provided ample sustenance to flocks of Lesser Egrets, Small Egrets, Pond Herons, and solitary Large Egrets.

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[1] This association has been noted near Bombay also. See *J. Bombay nat. Hist. Soc.* 39 : 101.—EDS.

In the centre of the Banni is an extensive oasis of large shady Acacias casting deep pools of shade, cool and restful after the sun-drenched Banni. The grass was refreshingly green. Large herds of cattle and buffaloes stood around under the trees, attended by Cattle Egrets. The inhabitants are Jhads, a cattle-herding tribe. They are well-built people and, though they are Muslims, their women go around unveiled and appear to enjoy a status equal to the men.

Leaving Brindiala, as this oasis is called, and proceeding again into the dazzling brightness of the Banni, we passed a couple of small herds of Chinkara, which do not seem to be at all as plentiful as claimed; nor did we come across any Black Buck or other game, big or small. Undoubtedly the Banni no longer enjoys its former status of a small game paradise, and is certainly not behind the times in this respect compared with the rest of India; man's predation is greater and more effective than is believed outside Kutch.

The commonest animal of the Banni was the Spinytailed Lizard, *Uromastix hardwicki*, sunning itself on the baked sand. Its performance of suddenly vanishing after a short spurt was intriguing until one realised that the disappearing trick was done down its burrow. These lizards are undoubtedly the chief provender of the large numbers of passing birds of prey during the autumn and spring migrations. Certain nomadic tribes of the area consider that this lizard's flesh has strong aphrodisiac properties and regard it as a valuable delicacy. . . . And so in time for an early lunch in Khavda.

At Khavda, arrangements had been made for our stay at the police chowky. It was in a way like a home-coming, as we had been here in the summer of 1956, unsuccessfully on a similar errand, and were then as now hospitably accommodated by the local officials. Things had changed little in the intervening years and, except for a block of new orderly quarters in the large enclosure, everything was as it had been then—time might well have stood still for the period. As some high dignitaries were on a routine inspection, we saw little of the officials who had been making arrangements for guides and baggage animals to take us to Nir. The chief guide Jamal Nathu was nowhere in town, and there was no news of him. 'He might arrive this evening', they all said. Camels were also not available for hire readily. It was very depressing and it seemed that after all we were stranded. The doy all of a sudden lost its charm, and we dejectedly prepared for lunch and then to await developments in the afternoon. Just then someone said Jamal had arrived and sure enough there he was standing in the doorway, a thin dark man dressed in the manner of his people. Spirits revived and lunch was forsaken to get all information out of him. He was optimistic, as there was still plenty of water in the Rann, and large numbers of flamingos fed along its edges. They had no young with them, and so it was obvious that the birds were still at the colony site and had not moved off; the camels and ponies had also arrived and were grazing on the turf of the village tank, so we could leave for Nir the first thing next morning. The well-cooked lunch, a tribute to the long catering arm of the Modern Hotel, and a short siesta were followed by an afternoon of baggage sorting. In the cool of the evening we went for a stroll to see our pack animals, and to record what birds were around. In addition to the usual birds one sees around any village tank in Kutch, we saw a Wryneck, a little Green Heron, and a pair of Laggar Falcons.

18 April 1960. The sturdiest camel was loaded with all the baggage, three others and two ponies were to be used for riding. At 7.50 a.m. the cavalcade started across Pachham towards the north-west end of the Island where the spurs of Kala Dongar subside into soft undulations and finally give way to the flat expanse of the Rann. The entire way is well covered by scrub, and there is little cultivation. Cattle-rearing is the chief occupation, and there are signs of considerable overgrazing. The little cultivation done is of a perfunctory nature and depends entirely on the vagaries of the monsoon rains. Much of the land is deeply eroded. The thickets however were well populated by Grey Partridge, Rain Quail, Purple Sunbirds, Redvented Bulbuls, White-eared Bulbuls, Rufousfronted Wren-Warblers, Franklin's Wren-Warblers, Common Babblers, Tailor Birds, Common Mynas, Brahminy Mynas, Redwinged Bush Larks, Ring and Little Brown Doves, and Roseringed Parakeets. Common Sandgrouse were noted flighting in pairs and small parties. The heavens overhead were quartered by King Vultures, Whitebacked Vultures, Longbilled Vultures, and white Scavenger Vultures accompanied by a few Griffons. Tawny Eagles were also seen soaring in loose pairs, while in the shady Banyan over the well at Wadvala, known as Wad-vali Wav, a pair of Redheaded Merlin had three young in the nest. A pair of Laggar Falcons and a Peregrine were also recorded. At

Kakrao where we spent the heat of the day under a densely shaded small tree, we heard and later saw a Raven. It was there on our return.

From Kakrao we rode north. After descending the last low ridge we came to the Rann, and then turned east along its edge. On our right the great escarpment of Kala Dongar rose steeply—great beetling crags covered by thick tangled scrub and grass, still showing green. Birds were plentiful, and their songs were carried in a disembodied symphony from high overhead. Indian Robins were very plentiful with Baybacked Shrikes (many in juvenile plumage) and pairs of Brown Rock Chats.

Where the slopes eased to form narrow flat areas between the perpendicular of the Kala Dongar and the horizontal of the Rann, the subsoil water was sweet, and herds of cattle were pastured, their tingling bells bringing to mind the high pastures of the Himalayas.

On our left stretched the Rann—startlingly flat and immense; first a white encrustment of salt shining in the sun, then wet mud dark brown and rich, and beyond this the blue water, rivalling the sky overhead and stretching to the horizon where it shimmered into the sky, and it was difficult to discern where one ended and the other began. Here was a region where desert and water had become one in essence, vast and limitless, a land of silence, ruled by the wind and the sun, a home of dancing mirages, a region forbidding yet fascinating in the starkness of its elemental harshness. Yet it was awe-inspiring to see on this cruel stage life playing its part in the great flocks of pink flamingos feeding in the shallows, flying in skeins low over the water or writhing high above the mirages and merging into their unreality like ethereal beings, frail phantoms epitomising life, fragile yet all-conquering. A little further we came across packed flocks of Blackwinged Stilts, Stints, Ruffs and Reeves, Marsh Sandpipers, Whimbrel, Sand Plovers, and some Blacktailed Godwits. Gullbilled Terns, Blackheaded Gulls, and Brownheaded Gulls flew buoyantly over the water. Tired but happy, we rode along slowly, drinking in the sights of this improbable land. Here was grandeur and beauty rivalled by few other creations of Nature.

We made Nir late in the evening as the setting sun cast a warm glow on the wonderful landscape. The mirages subsided and far out on the northern horizon we saw lines of pink and white, which Jamal said were Flamingo City. The birds were still breeding. A memorable day had ended well, and tired and happy we lay under the brilliant stars, worn out but contented.

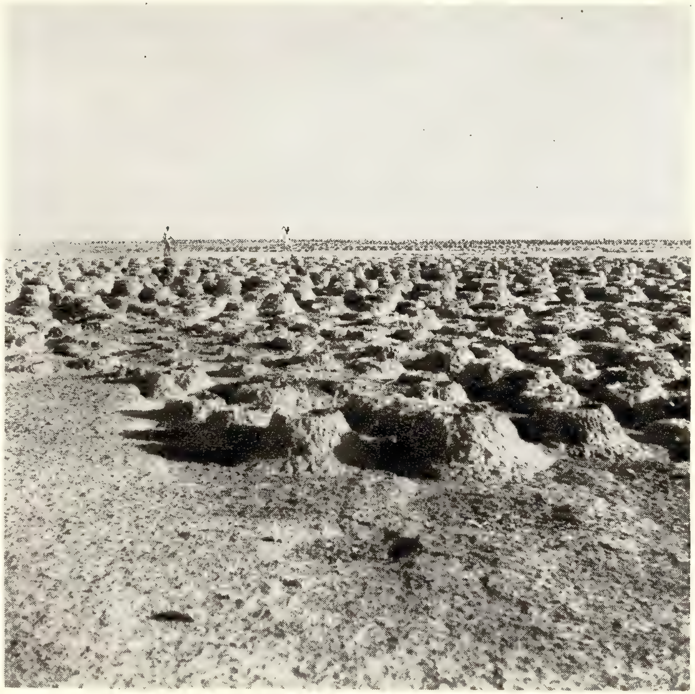
19 April 1960. The pink light of dawn rekindled the scene. In the direction of Flamingo City masses of pink would blaze up and resolve into long undulating lines of flamingos flying south to the water off Kunaria or to the west to feed on the edges of the Rann where we had already seen the vast flocks on our way to Nir.

With thrilled anticipation we broke camp, loaded the animals and after watering them, set off for the colony. The direction was north-east of Nir, and traversing a dense stand of tall *Calotropis* sp. alive with sunbirds and bulbuls, skirting a green pool of fresh water over which hovered and wheeled terns and gulls, we came to the edge of the Rann and, crossing a short expanse of wet and slippery mud in crossing which the camels fared ignominiously, we entered the water. Throughout the whole distance, some seven miles in a straight line, the water was from a few inches to a foot and a half deep, clear, and with a few shoals of varieties of small fish many of which were dead, floating belly upwards, and well preserved in the concentrated brine.

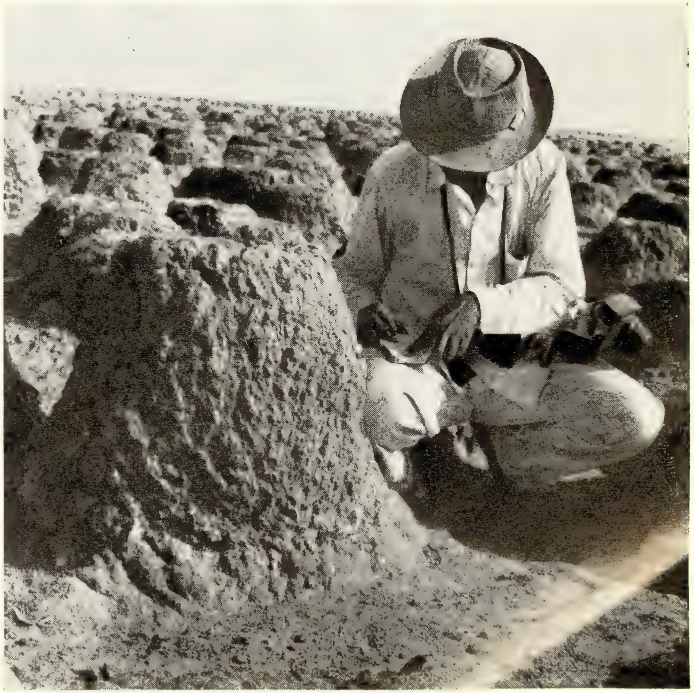
Flamingos fed singly and in small groups in all directions, while lines of birds flew by in wavering ribbons between the blue sky and the blue water sparkling in the morning light. Flocks of Gullbilled Terns and Blackheaded Gulls flew around and over us. Tight flocks of Marsh Sandpipers fed busily in the shallows and large numbers of Ruffs and Reeves, Redshanks, Sand Plovers, and Stints flew fast and low towards the north. A small group of Whitewinged Black Terns also went over.

The camels, so sure-footed and aloof on dry land, were in a hopeless condition, floundering in the wet mud; in water they fared slightly better but their pace was agonisingly slow. On several occasions they almost landed the riders and the baggage in the water. Had such an unfortunate accident occurred, the entire expedition would have been in a pretty mess indeed. The horses soon outstripped the camels and were lost in the distant haze, leaving a long black trail in the water and mud for the cumbersome 'ships of the desert' to follow as best as they could. For the horsemen the ride was a pleasant experience as they watched the birds and moved with safety and speed across the watery miles, but for those on camels the morning soon lost its sparkle and, as the haze and mirages shortened the horizons around them, the heat of the sun overhead and the glare of the water below induced a state of torpor, livened only by occasional clouds of pink as flamingos far beyond the curtain of mirages rose before the horses, or a numbed limb shot a complaint through the already strained spine. The hours slipped by, and yet we seemed to be in the same place, as in a dream. It was as if we

Flamingo colony in Rann of Kutch

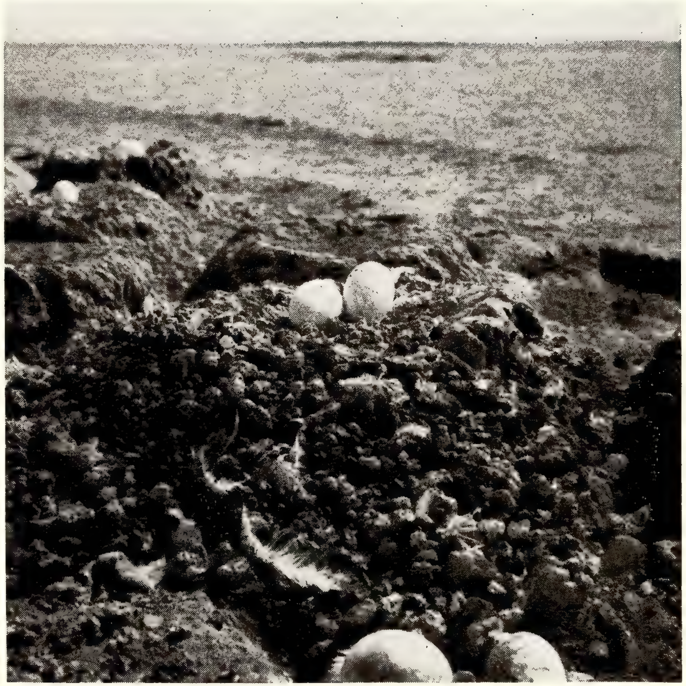


'Nests and nests for hundreds of yards'

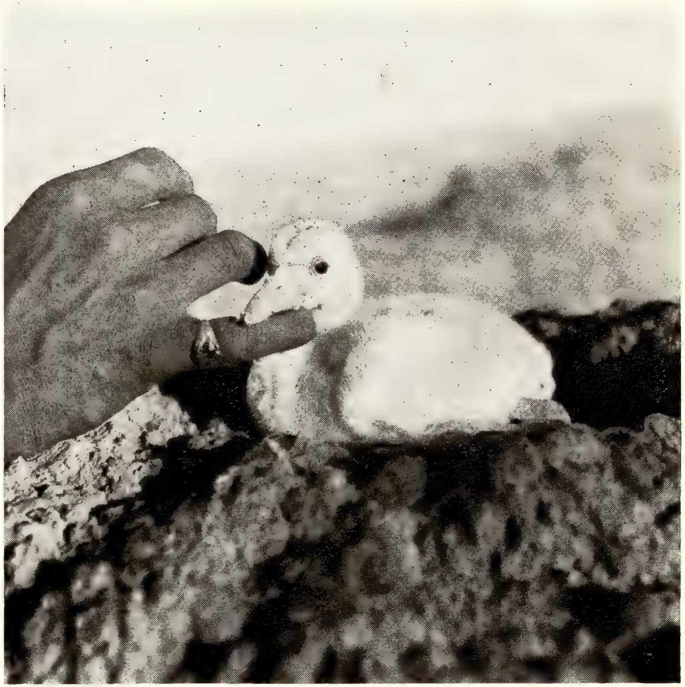


A large mound in the main colony

Photos : Authors



Flamingo nests of mud pellets with 2 eggs



Newly hatched Flamingo chick

Photos : Authors

had become one with timeless space, and everything had reached a standstill in eternity. It was therefore with some effort that it dawned on us that we had arrived. In the distance could be seen ranks of white birds. A clump of black forms making their way grotesquely across some dry sand turned out to be pelican fledglings in their black down, and the larger forms were the ponies and the rest of the party. It was all still unreal, as we came on to dry salt-encrusted sand. Getting off the camels, we walked the rest of the distance to ease our cramped legs. The sight of the flamingos was beyond belief. The fabulous birds were atop their mound-like nests, some standing and others sitting, their graceful necks curved over their backs. Every now and then, heads would rise high and pink wings would open and flash in display and the soft murmuring from the tending birds rose incessantly like distant surf on rocks. Behind the peaceful congregation of sitting birds there were in the water, now several hundred yards from the colony, rank upon rank of birds feeding with young in tightly packed rafts among their feet—a sight indeed worthy of the gods! There we sat in the blazing sun with the amazing spectacle spread before us. Years of longing had at last come true and, in a dreamlike comprehension, we scanned the great expanses of baked mud, the clustered mounds of mud nests rising from them, and the graceful pink forms poised above.

At long last we bestirred ourselves, pitched the tent for shelter from the sun, and assembled the photographic hide, and then we lay down for the afternoon. The birds were content on their nests, while files of incoming birds were met by outgoing birds, and ripples of fire would spread and subside as birds rose, stretched their wings, and settled down again. We flattered ourselves as about to achieve a long cherished hope. The birds were there, albeit fewer than those seen by the earlier party, but their numbers were still in the thousands, and above all they were ridiculously tame, or so they seemed, and took not the least interest in our tent and ourselves, though we loomed conspicuous on the flat and limitless Rann. Before sundown that day, things were to turn out differently, and a well-planned expedition was to fail on account of over-familiarity induced by the birds' own tameness. This showed us forcefully how no chances can be taken when working with wild creatures.

At 2.00 p.m. some 200 Rosy Pelicans appeared overhead. They circled around, at first high and then, in successive spirals, lower and lower, providing a magnificent display as in formation they gracefully rode the air currents revealing a mastery over the art of flight. In this manner they soared effortlessly for a couple of hours, and it was obvious that they had not taken kindly to our presence so close to their nesting ground. They finally departed, flying south from whence they had come. A few of them however circled round and landed to the north in the water. Their gawky black chicks were all in a huddle among the old flamingo nests on the southern side of the 'City', sheltering as best they could from the fierce heat of noon. Soon after, the baggage men and animals left us to our lonely vigil in the boundless spaces with the wind and the birds.

When the sun dropped to the western horizon and the heat abated, we went on our various tasks of examining the deserted section of the colony, looking over the pelican nests in which there were still many nests intact with feather lining and two eggs, deserted by the parents when the major breeding was over, and trying to capture some newly hatched flamingos for their vomit for analysis by the Society. The capturing of the young flamingos was ill-advised and should have been attempted on the very last day, as this greatly disturbed the sitting birds and they now coupled us and our manifestations with predators. The tent and all movement, which till now had caused them no concern, were now suspect. They became suspicious and it was clear that there would be a risk in attempting close range photography near the colony and, so as not to disturb the birds any further, all operations in the vicinity of the colony were stopped. The fact that the majority of the birds had left with their chicks and made for the water, which had receded from the site, must have greatly weakened the attachment of these late breeders, and any intrusion now would surely snap the slender thread of emotion holding the dwindling group of breeders together and cause them to desert. Unhappily we called it a day and decided to move our camp the next morning and watch the birds from afar. The counting of the occupied nests was to be done just prior to our departure; photography and data collection was not to be done, for fear of frightening the birds.

20 April 1960. Before sunrise the camp was shifted to the far end of the mudflat about 2000 paces from the colony. It was a backbreaking task. Under canvas, we prepared to pass the day watching and observing whatever little we could from the distance. The sun rapidly mounted in the heavens; the heat was intense, and the mirages sprang up around us obscuring the flamingos and their colony from view. Some Desert Larks arrived to hunt for insects among the cracks in the mud, and then flew off. Lost amidst the unusual surroundings, a Ring Dove alighted for a short while, while a Wryneck pretended that bits of driftwood were tree-trunks. A male Blue-headed Wagtail also paid a short visit. Flocks of Ruffs and Reeves hurtled past, and isolated groups of Stints twittered by. At noon Jamal arrived on his white pony with fresh water and curds. We had lunch off tinned fruits, and lay back as the formations of pelicans came soaring over from the south. They finally settled among the deserted flamingo nests close to their chicks, who came over to be fed; the actual process could not be seen clearly on account of the mirages. After Jamal departed for Nir we strolled across to the northern edge of the mud flat to watch the great masses of feeding birds with their chicks. Great masses of flamingos stretched along the horizon half a mile out in the water, with tightly packed clusters of dark chicks among their feet. These were in all stages of development from very small white-downed birds to brown-feathered birds several months old. The birds extended across 40° of horizon. We were thrilled to see a flock of 77 Lesser Flamingos in vivid plumage. They later flew off into the setting sun. Lines of the larger birds flew to and fro, going to and coming from the distant feeding grounds in an unending cavalcade. The sound made by the feeding birds was a constant roar like that of distant waves. The evening was a gorgeous one. At sundown, the pelicans were still with their young, clouds of midges flew over the tent, and in the deepening dusk flamingos passed low above us to the colony like the ephemeral forms of apasaras.

21 April 1960. The pelicans had spent the night with their young, many of which had been led away into the water to the north. Soon after dawn the adults left. We all went over to the colony to count the occupied nests and to do what little was possible for the cause of science. This had to be done as rapidly as possible so as not to disturb the birds for too long. No catching of young was to be done. Very soon we were back in camp, making ready to leave immediately the camels arrived.

The transport arrived at noon and they fetched with them an ever-welcome refreshment of curds. Two of us took the ponies and rode out into the water to have a closer look at the feeding adults and their chicks. The huge population of flamingos was amazing and the young were conservatively estimated at not less than half a million. Undoubtedly, this year's breeding has been the most successful ever. The abundance of water in the Rann so late in summer augurs well for the hordes of young reaching maturity.

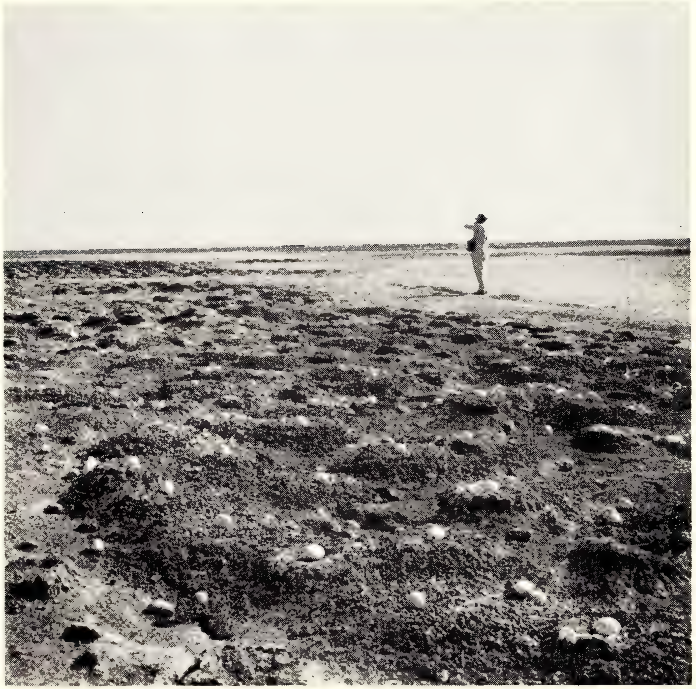
Late that night we arrived at Nir. A strong westerly wind had driven the water away from large parts of the track but Jamal assured us that as there was ample water on the east of Pachham there was no possibility of the birds being left dry even if the wind were to persist for several days. Thus ended a memorable experience, and despite the failure of our primary purpose of photographing the birds at close range, great experience had been gained. Notwithstanding the severe physical hardships endured, the next season's visit is looked forward to with keenness.

OBSERVATIONS

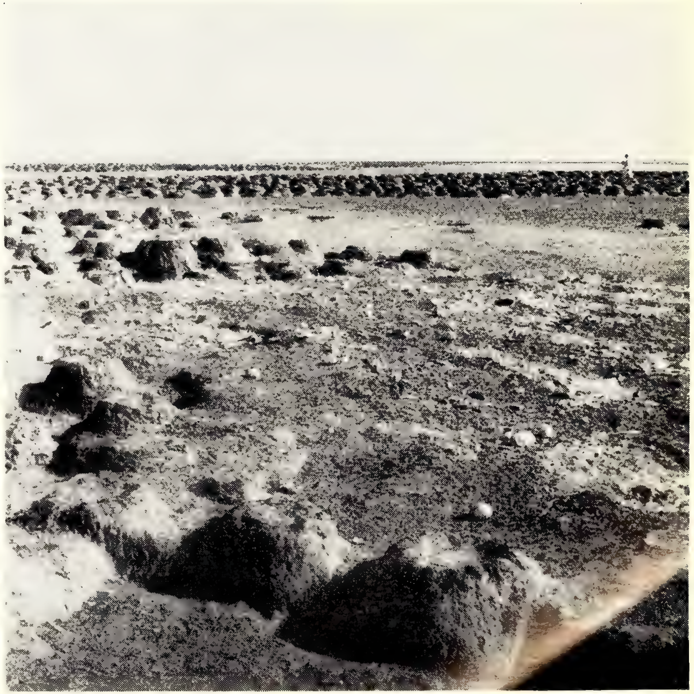
Only a portion of the breeding flamingos, reported by Dr. Sálim Ali [*J. Bombay nat. Hist. Soc.* **57** (2): 412-4] were still on the nest site. Approximately 2000 nests were still occupied. The water had receded a couple of hundred yards from the colony. The majority of the tenanted nests had obviously been constructed after the water had receded and were very low and composed of flaked pieces of mud, whereas the older nests were all tall and well-constructed or well-fashioned, and were made of smooth plastered mud. These nests were however built on the remains of the older nests, whereas some of the nests in occupation were of the taller type and suggested that they had been built earlier and must have been used twice and even thrice in the same season. It naturally is not possible to say whether the same pair were rearing supplementary broods, or whether newcomers had taken over after the original owner had vacated.

Six separate groups of nests were in habitation, but even the largest group was very insignificant beside the now vacated colonies. The largest occupied colony had an area of 1436 sq. yards, whereas the smallest was 30 sq. yards in area. In the largest colony still in use, a sample count yielded 3300 nests, of which only 1600 contained eggs, and there were 9000 eggs lying outside in heaps or smashed. Large quantities of eggs lay half buried in the mud and were not included in the count. This shows an enormous wastage of eggs, either accidentally rolled off the nests by the parents, or rolled off by predatory Neophrons. In another colony of 300 nests 30 were occupied and there were 340 eggs on the ground. However, it should be noted that the number of eggs on the ground was much less in other colonies, and in the large colonies which were unoccupied at the time of our visit the number of eggs on the ground was very much lower and even insignificant. Of course, Neophrons may have destroyed and eaten up many of these eggs in the unoccupied colonies.

The clutch was usually of one egg, though several nests contained



The largest occupied Flamingo colony. Note eggs on ground and low nests of mud flakes on remnants of older nests



Rosy Pelican eggs and nests on border of Flamingo colony

Photos : Authors

two. One egg was freakishly small measuring 41×32 mm. and weighing 17 gm.

The colony site has most certainly been in occupation since about November judging by the brown plumaged juveniles among the other chicks. The latest brood had only just commenced to hatch. Several eggs were piping and their sound was audible at a distance. The surprising fact is that these eggs and the very young chicks can withstand the severe extremes of temperature experienced on the Rann. We were struck by the intense dessicating heat during the day and the comparatively cool nights which followed. In the water, the wind, which was at all times very strong, must have proved a formidable factor for the smaller chicks. The enormous rafts of young in the shallow water always had a few adults with them, the proportion being 1 adult to 50 young and even one adult to 100 and more young. It was observed that these adults flew to water in the south for feeding and there were regular flights in the morning and evening. Why these birds had to fly so far to feed when there must have been ample food near by remains a mystery. Probably the other feeding grounds were richer than these, though these supported hundreds of thousands of young in a very small area of a few square miles. The organic content of the mud in the water where the young were feeding was 5%. This included plenty of minute organisms in the water, easily seen when held up in a glass against the light.

Predation: During favourable years death by natural factors does not seem to be very significant and the number of dessicated remains of chicks of all ages was very small and, in addition to systematic predation by two or three pairs of Neophrons on unguarded nests and isolated chicks, the greatest loss is obviously by the parents accidentally rolling their eggs off the nests, which is proved by the masses of eggs lying around in the mud. In the Great Rann predation is apparently of small consequence, as the only predators present regularly were the Scavenger Vultures, but these can hardly account for more than a small fraction of the eggs and chicks which are reared. Man does not seem to enter into the picture, as the colony is so isolated. It has however been reported that some of the villagers on the edges of the Rann do capture chicks in the running stage when the birds scatter to feed in the shallows fringing Pachham. But this can have little effect on the numbers of birds. Loss of life is mainly caused by natural catastrophes, as reported by McCann.

Nests: Nests varied considerably in size from one colony to another, but were remarkably uniform in each colony. It was obvious that nests, built when the water stood over the site, were taller and well constructed. They were more closely situated and the tops of these were from 9 to 12 inches apart. A tall nest was 23 inches high, 15 inches across at the top, and 26 inches wide at the base. The other nests were not very much smaller than this in the older colonies. Around the colonies were deep troughs made by the birds dredging mud for their construction work. The newer nests were smaller in comparison and were never more than a foot and a half tall. Mostly they were less than a foot. Neither were they as dense. The nest density varied from 130 nests per 100 sq. yards to 200 nests per 100 sq. yards in the older colonies.

Pelicans: The Rosy Pelicans which have been nesting alongside the Flamingos are a 'first' for the country, and Dr. Sálim Ali found them with eggs and newly hatched squabs. He had estimated 3000 adults busy at the operations. By the time of our visit the actual nesting had been completed, and only 200 large and ungainly young pelicans and many deserted feather-lined nests remained. The majority of the young had already been led away into the water among the flamingos, where they patiently awaited their parents, floating serenely among the wind-whipped waves. The remaining juveniles were all about the same age, very ungainly, and misshapen. They were covered with a dense black down, and only in a few of the oldest had the primaries emerged and two white bands of feathers showed on the crown. All had well-developed subcutaneous air-sacs. They spent the entire day among the old and deserted flamingo nests, huddling together for protection from the heat of the sun and the cool wind at night. They could walk well, though some of the smallest were still a little wobbly on their legs. When approached close, they turned to face the assailant and snapped viciously with their still weak bills. During the hottest part of the day they kept cool by a continual gular fluttering.

The fact that the squabs at this stage are voluntarily left by the parents, for such long periods in the blazing heat is highly significant. Bartholomew & Dawson (*Ecology* **35** : 466-472, 1954) pointed out how the behavioural responses of the adult Brown Pelican *P. occidentalis californicus* depend upon the temperature regulatory ability of the young. According to them the mechanism of temperature regulation is poorly developed in the naked newly-hatched pelicans and, for this reason, they are largely dependent on their parents for protection from the elements; adults are very attentive to their newly-hatched offspring and show a marked reluctance to leave them, and will remain at their stations even when approached to within 10 to 15 yards. With the increase in homothermy in their nestlings, the adults show a progressive decrease in attentiveness, and the behaviour of the Rosy Pelicans suggests that the temperature regulating capacity of these young was perfected. That they were also able to withstand hunger for prolonged periods was also apparent from the fact that they endured a 48-hour fast without any unfavourable reactions during the first days of our camping at the colony.

Heaps of semi-digested fish were noted around the colony and had been regurgitated by the parents[1]. A heap of average size contained 1 to 2 lbs. of fish. These were from an inch to two inches long. Some of them were collected by Soman and have been identified as *Cyprinodon dispar.*

It would be interesting to know what were the factors that led to these pelicans favouring the Rann for breeding this season, and whether they will do the same next year if the present monsoon rains prove as abundant as those of last year.

Miscellaneous: Insect life, represented by midges[2] flying over the nests and our camp, earwigs scuttling under the cracking mud, and beetles (? spp.), was plentiful. Numerous spiders stretched their webs between the flamingo nests. A hornet and a butterfly were seen but could not be collected. The enigma arises as to how the non-flying members of the insect community arrived here, especially as there are miles and miles of water separating the flamingo-flat from the nearest land.

CONCLUSION

Here for the ornithologists of India is a challenging problem. The study of the factors controlling the largest congregation of Large Flamingos in the world would be revealing. Unfortunately, the breeding cycle of this bird in the Great Rann is very erratic, and depends on the vagaries of the monsoon rains so characteristic of these parts. In addition, the colony is relatively inaccessible, and can only be reached after a long and arduous journey, during which human endurance is subjected to the severest test, and what ornithologists have done up to date is a mere collection of fragmentary evidence during their occasional visits, unhappily only too brief. A study of the Rann would therefore be interesting and needs a greater endeavour than that of the past. Prolonged stay on the site and a detailed study of the conditions of water are necessary. Small groups of birdmen could man a station at Nir and observations could be continued over the entire breeding period. This would necessitate organisation on a level which precludes the individual efforts of stray amateurs. The effort would most certainly add a tremendous contribution towards the understanding of bird behaviour and their movements and provide a landmark in the science of ornithology. It is hoped that in the not distant future Indian ornithologists will accept the challenge, and a detailed project of studies such as envisaged above will be undertaken.

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[1] Dr. Sálim Ali states that these lumps of fish were disgorged by the young. See *J. Bombay nat. Hist. Soc.* **57** : 414.—EDS.

[2] Specimens collected have been identified as Fungus Gnats (*Sciara militaris*).

Ferns of Nainital

BY

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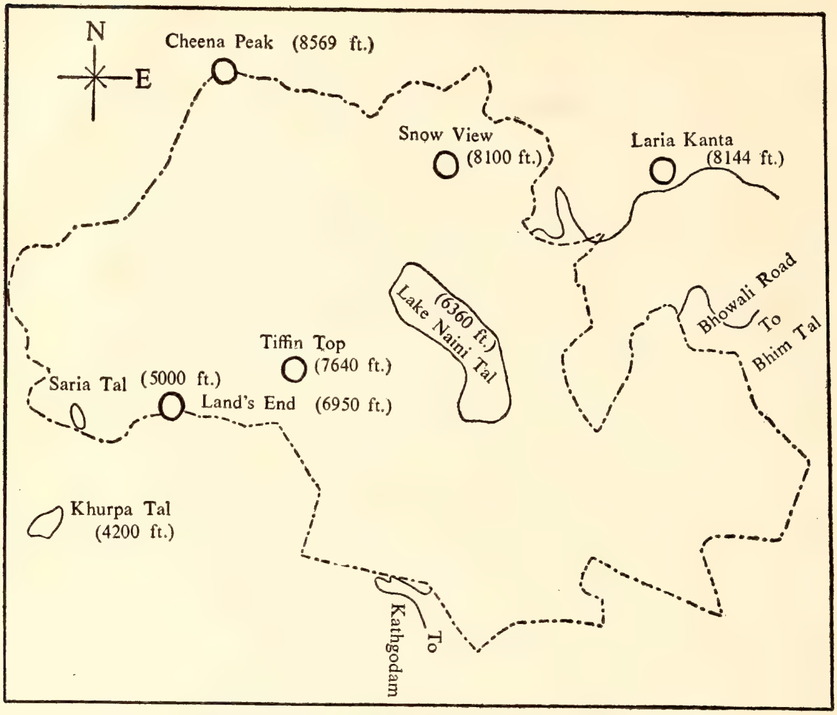
(*With one map*)

The present account of Nainital ferns is the result of an extension of cyto-morphological and cyto-taxonomical studies already carried out by the authors in the Darjeeling and Sikkim Himalayas from 1954 to 1958. A perusal of the literature on Indian ferns indicates that, besides Clarke (1880), Beddome (1863, 1892), and Hope's (1899-1903) excellent contributions dealing with the fern flora over vast areas, some later workers (Strachey, 1906 ; Blatter & d'Almeida, 1922 ; Mehra, 1939 ; Stewart, 1945, 1951 ; Raizada, 1954, and Alston & Bonner, 1956) have made intensive studies in comparatively restricted areas. It is needless to stress the importance of local fern floras of this sort. Such accounts are desirable for almost all the important and accessible regions in the Himalayas, particularly due to the revived interest in fern cyto-taxonomy. Apart from this there have recently been serious changes in nomenclature and most of the names employed in the various previous reports are no longer valid. Hence it is imperative that the new fern floras whether local or pertaining to larger areas should apply recent nomenclature. These are likely to be of great help to future collectors, especially those interested in the cyto-taxonomic aspect. It is with this idea in mind that the present investigation was undertaken by the authors. The present paper contains a list of the species collected primarily by the authors, together with their ecological notes. Other species that have not been observed by the authors but were reported earlier by Strachey (1906) from Nainital have been incorporated with a view to complete the list. These will be searched for in later visits.

The hill station was visited during July-August 1959. The altitudinal range covered is from 1700 ft. (518 m.) at Kathgodam (railway terminus) to 8569 ft. (2612 m.), the height of Cheena Peak. The present collection has been limited to Nainital proper and its neighbouring localities. Round about Nainital there are seven lakes including Nain Tal ; out of these four, namely Naini Tal, Bhim Tal, Saria Tal, and Khurpa Tal, were visited. The various mountain sides searched for ferns are shown in the map on p. 480.


N
E
Cheena Peak (8569 ft.)
Snow View (8100 ft.)
Laria Kanta (8144 ft.)
Bhowali Road
To Bhim Tal
Lake Naini Tal (6360 ft.)
Tiffin Top (7640 ft.)
Saria Tal (5000 ft.)
Land's End (6950 ft.)
Khurpa Tal (4200 ft.)
To Kathgodam

Map showing the area searched for ferns

The recent system of Copeland's (1947) classification has been followed for the sake of convenience. The most recent nomenclature has been used, following Ching (1936, 1938), Copeland (1947), and Holttum (1949, 1954). It may be pointed out that Nainital proper is rather poor in fern flora so far as the number of species is concerned, though from the entire region of Kumaon Strachey (1906) has catalogued many more species. However, prolificity of certain species is well marked. For instance, *Onychium contiguum* (Wall.) Hope and *Athyrium schimperi* Moug. in certain areas cover the entire aspect of several hillocks, and amongst the epiphytes *Araiostegia pseudocystopteris* (Kze.) Copel. and *Pleopeltis kashyapii* (Mehra) Alston & Bonner are among the exceedingly common species.

CLIMATE

Nainital proper (29° 23′ N. and 79° 30′ E.) is situated in the outer ranges of the north-western Himalayas and receives an average rainfall of 98 inches (249 cm.) annually. The chief amount (70 in.=178 cm.) falls during the principal rainy months (from June to October). It is during this period that almost all the ferns bear new fronds and the fern vegetation is at its best. By about the end of the rainy season the spores are mature for dispersal. The average temperature is 58° F. (14.5° C.) during August and September. This is followed by a dry period beginning from October when the temperature falls down to 45°F. (7° C.). The winter is marked by the resting period of ferns, especially the epiphytic ones at Nainital level and above.

The soil in these mountains is comparatively loose and rich in clay covered over by humus layers in the forests. Limestone rocks are occasionally observed which are inhabited by several xerophytic species.

ECOLOGICAL OBSERVATIONS

The difficulty of classifying the vegetation type of the monsoon forests has been experienced by many previous workers. This seems particularly true of ferns, since a large number of species here show great altitudinal range and occupy diverse habitats. In such cases, therefore, no hard and fast line of demarcation is feasible. In view of this difficulty the various species have been classified on the basis of their ecological habitat.

Forest Floor Ferns

The forests around Nainital are mainly made up of *Quercus dilatata* Lindl., *Q. lanuginosa* Don, and *Rhododendron arboreum* Smith. Some of the other trees that were observed were *Acer oblongum* Wall., *Viburnum cotinifolium* Don, *Betula alnoides* Buch.-Ham., *Carpinus viminea* Wall., and *Ficus clavata* Wall. (at Bhimtal). These forests are fairly thick, and the requisite amount of moisture is available for the ground-growing as well as the epiphytic vegetation. The lofty trees provide shade and prevent rapid air movement to a considerable extent. The soil is rendered rich in humus. Under these conditions, a large number of species have been found to grow and thus these forests symbolize the climax fern vegetation of the area. In strong contrast to this, fewer species find favour in the pine and cedar forests. The commonest species recorded above 4000 ft. (1219 m.) altitude are :

Pteris cretica L.
Dryopteris odontoloma (Moore) C. Chr.
Polystichum squarrosum Don
Athyrium schimperi Moug.

Besides, *Dryopteris marginata* (Wall.) Christ and *Polystichum aculeatum* Sw. are less frequent. Forest margins and the roadsides are densely inhabited by *Cheilanthes dalhousie* Hk. and *Asplenium alternans* Wall. Wherever open situations occur, *Onychium contiguum* (Wall.) Hope forms beautiful beds and appears to be the only dominant species in such areas. *Pteridium aquilinum* (L.) Kuhn needs special mention. This species occurs as a weed over extensive usually open areas throughout the Himalayas between 4000 and 8000 ft. (1219 to 2438 m.). However, at Nainital it could only be located at some distance below the Laria Kanta peak (8000 ft.=2438 m.). Some of the open and exposed rocks on the road to Cheena Peak are colonized by *Gymnopteris vestita* (Wall.) C. Chr., popularly known to European botanists as the Mouse-ear Fern. *Phymatodes oxyloba* (Wall.) Presl. covers the shaded aspects of the entire rocks or boulders lying in the open between 6000 and 7000 ft. (1828 to 2133 m.). This fern is more of a lithophyte than of the forest floor. In contrast, however, *Adiantum venustum* Don has an aptitude for extreme shade and moisture and has been collected in plenty in the forests above 6000 ft. (1828 m.).

The roadside and the forest floor aspect at lower elevations (2000 to 4000 ft.=610 to 1219 m.) is somewhat different. The entire masonry work as well as the open forest paths are extensively colonized by *Adiantum incisum* Forsk. In contrast to this, *Adiantum lunulatum*[1] Burm. requires very moist and shaded but somewhat open aspects. The forest floor at lower elevations has a smaller variety of ferns. Amongst the commonest are :

Dryopteris cochleata (Don.) C. Chr.
Cyclosorus dentatus (Forsk.) Ching
Pteris vittata L.
Lygodium flexuosum Sw.

Another prominent species of this area is *Hypodematium crenatum* (Forsk.) Kuhn which is very partial to limestones and grows in the crevices of these rocks. The drier aspects on the roadsides are inhabited by *Cheilanthes farinosa* Kaulf. whereas *Tectaria macrodonta* (Fee) C. Chr. abounds in deep shaded and moist habitats.

Ravine Ferns

In general there are very few true ravines round about Nainital. Along Nainital-Bhowali Road several ravines were located which were almost devoid of direct sunlight. In contrast to the general forest floor atmosphere and open places, ravines are far more humid. They provide a congenial atmosphere for the hygrophytic ferns to flourish. Most of these ferns are large-sized with more or less herbaceous foliage. The commonest species that occur on the gravelly soil along the water channels are :

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[1] This is usually referred to as *Adiantum philippense* L. in recent nomenclature. The nomenclatural change adopted here will be discussed separately by the junior author.

Thelypteris erubescens (Wall.) Ching
T. repens (Hope) Ching
T. brunnea (Wall.) Ching
Diplazium polypodioides (Mett.) Bl.

Many boulders in these localities have a thick velvety covering of mosses which provide an excellent substratum for the humicoles notably *Araiostegia pseudocystopteris, Adiantum venustum, Asplenium varians,* and *Microsorium membranaceum* (Don) Ching. The common inhabitant of the ravines at lower altitudes (2000 to 4000 ft.=610 to 1219 m.) is *Cyclosorus dentatus.*

Epiphytes

While rambling in these forests it is interesting to note that epiphytic vegetation is rather poor in this part of the Himalayas, in strong contrast to comparable altitudes in the Darjeeling and Sikkim Himalayas, where the number of epiphytes is extremely large. As one proceeds westwards the epiphytic vegetation is still meagre as is evident from the recent report of Schelpe (1954) from Kulu. The rainfall in the Himalayas decreases from east to west (Darjeeling, 121.7 in.=309 cm. ; Nainital, 97.4 in. =247 cm. ; Mussoorie, 80 in.=203 cm. ; and Kulu, 43 in.=109 cm.) and this seems to be the probable reason for the paucity of epiphytic vegetation in this part of the Himalayas. The most dominant epiphytes around Nainital are :

Araiostegia pseudocystopteris (Kze.) Copel.
Goniophlebium microrhizoma Clarke
Pleopeltis kashyapii (Mehra) Alston & Bonner
P. linearis Thunb.

The only species exclusive to Nainital which has not been observed in other parts of the Himalayas is *Drynaria mollis* Bedd. It is a common epiphyte around Nainital above 7500 ft. (2286 m.). *Loxogramme involuta* Don is rather less frequent. At lower altitudes (1000 to 3000 ft.=305 to 914 m.) *Pyrrosia flocculosa* (Don) Ching is an exceedingly common epiphyte in addition to *Pleopeltis linearis.*

LIST OF SPECIES

Order OPHIOGLOSSALES

OPHIOGLOSSACEAE

1. **Ophioglossum vulgatum** L. Collected by Prof. P. N. Mehra in 1949 from Sat Tal but not collected by the authors within the area investigated ; apparently rare.

2. **Botrychium lanuginosum** Wall. Grows in patches on wayside rocks and gravelly soil on the road to Land's End and Khurpa Tal. Most of the specimens have their sterile pinnae becoming soriferous.

3. **B. ternatum** Sw. Collected by Prof. P. N. Mehra in 1949 from Laria Kanta side and also reported by Strachey (l. c.) from Nainital. Not observed by the authors.

Order FILICALES

SCHIZEACEAE

4. **Lygodium flexuosum** Sw. A common wayside scrambler near Bhujia Ghat (Kathgodam) and climbs on adjacent shrubs by the help of its stiff and wiry rachises.

PTERIDACEAE

5. **Dennstaedtia scabra** (Wall.) Moore. Reported by Strachey (l. c.) under *Dicksonia* from Nainital (alt. 6500 ft.=1981 m.) but not observed by the authors.

6. **Pteridium aquilinum** var. **wightianum** (Ag.) Tryon. Observed only in one locality below Laria Kanta (alt. 8000 ft.=2438 m.).

7. **Pteris vittata** L. One of the commonest rock-dwellers throughout the Darjeeling and Sikkim Himalayas, mostly associated with *Onychium siliculosum* (Desv.) C. Chr. and *Pityrogramma calomelanos* (L.) Link. At Nainital, however, it ranges up to 6000 ft. (1829 m.) and flourishes, even in moist and shaded situations inside the forests or even in the ravines.

8. **P. quadriaurita** Retz. Not uncommon in the forest on way to Laria Kanta (alt. 7000 ft.=2133 m.).

9. **P. cretica** L. The species can be identified in the field on the basis of marked difference in the size of its vegetative and fertile fronds. The pinnae of the vegetative ones are broader than the fertile ones with spinulose barren margins. Very common.

10. **Cheilanthes dalhousie** Hook. This is a common species around Nainital. The fronds are generally devoid of powder on the under surface.

11. **C. farinosa** Kaulf. Common all along the roadside from Bhowali to Bhim Tal on exposed rocks.

12. **C. subrufa** Desv. Only a single specimen was collected at Bhujia Ghat along the roadside ; apparently rare.

13. **Cheilanthes** sp. Intermediate between *C. albomarginata* and *C. farinosa* in frond characters. Densely scaly with dense white powder underneath. Very common from Bhowali to Bhim Tal.

14. **C. albomarginata** Clarke. A common fern around Nainital and Bhowali.

15. **Gymnopteris vestita** (Wall.) C. Chr. Collected only once on way to Cheena Peak, growing on an open rocky cliff. The species can be recognized by its dense covering of soft, silvery hairs which turn brown on ageing.

16. **Adiantum capillus-veneris** L. The species has a great altitudinal range from Nainital level, down to the plains. In the plains of the Panjab it grows on shaded and moist walls in wells and streamlets. It was collected from the roadside along the Mall (Nainital) as well as at Saria Tal. Plants are rather small in size and more dark.

17. **A. incisum** Forsk. Exceedingly common between 2000 and 4000 ft. (610 to 1219 m.) forming extensive matting on masonry work and on rocks by the presence of apical buds. In the Indian literature on ferns, it has been considered as *A. caudatum* L., but it differs from true *A. caudatum* in colour, general appearance, texture, and degree of cutting of the pinnae, in having smooth apices of the sterile pinnae and larger sori, and in not having its veins raised and prominent. Collected from Bhim Tal and Bhujia Ghat.

18. **A. lunulatum** Burm. Restricted to 2000 to 4000 ft. (610 to 1219 m.) alt. Collected from several mesophytic localities such as Mehra Gaon, Bhim Tal, and Bhujia Ghat.

19. **A. venustum** Don. Excellent specimens were gathered on way to Laria Kanta and Tiffin Top ; requires very humid situations.

DAVALLIACEAE

20. **Araiostegia pseudocystopteris** (Kze.) Copel. One of the commonest epiphytes in all the localities at Nainital level.

21. **Nephrolepis volubilis** J. Sm. Reported by Strachey (l. c.) at 6700 ft. (2042 m.) alt. but not seen by the authors.

ASPIDIACEAE

22. **Hypodematium crenatum** (Forsk.) Kuhn. A common xerophyte of limestone rocks ; generally observed at low altitude (2000 to 5000 ft. =610 to 1524 m.).

23. **Polystichum squarrosum** (Don) Fee. A fairly common species growing along the roadsides as well as in comparatively drier forests around Nainital.

24. **P. aculeatum** Sw. It occurs under the same habitat as the former species but is comparatively less common; collected on way to Cheena Peak.

25. **P. obliquum** (Don) Moore. Collected by Strachey (l. c.) at 6900 ft. (2103 m.) alt. but not seen by the authors.

26. **Cyrtomium falcatum** Sw. (Copeland, 1947, under *Phanerophe lebia*). Reported by Strachey under *Aspidium*, at 7000 to 8500 ft. (2134 to 2590 m.) alt. Not observed by the authors; apparently rare.

27. **Dryopteris odontoloma** (Moore) C. Chr. A fairly common forest fern met with in mesophytic localities. Apparently rare eastwards. It is significant to note that in Darjeeling it inhabits only the masonry work along the roadsides and was never observed on the forest floor.

28. **D. marginata** (Wall.) Christ. This is another conspicuous species of the genus growing along with the former but can be differentiated by its large size and often tripinnate fronds.

29. **D. chrysocoma** (Christ) C. Chr. Common in mesophytic localities and known to early botanists as *D. schimperiana*, the type of which is from Abyssinia. In view of several morphological differences, Ching (1938) retains the present name for the Himalayan plant.

30. **D. cochleata** (Christ) C. Chr. It is the only species of the genus restricted to low altitudes (2000 to 3000 ft. = 610 to 914 m.); also differs from other species of the area in having dimorphic fronds, the fertile ones being highly contracted. Fruits in September onwards.

31. **Tectaria macrodonta** (Fee) C. Chr. Grows on gravelly soil between 2000 and 4000 ft. (610 to 1219 m.) alt. Common near Bhim Tal and Bhujia Ghat.

32. **Thelypteris repens** (Hope) Ching. A common ravine fern. The fronds are characterized by the presence of unicellular needle-like hairs on both the surfaces. Nainital-Bhowali Road.

33. **T. erubescens** (Wall.) Ching. Grows in the same habitat as the *T. repens*; differs from it in having exindusiate sori. Nainital-Bhowali Road.

34. **T. brunnea** (Wall.) Ching. The species is characterized by

ex-indusiate sori which are slightly elongated along the veinlets. Collected only from one spot along Nainital-Bhowali Road.

35. **T. sub-villosa** (Moore) Ching. Reported by Strachey (l. c.) under *Polypodium auriculatum* ; not observed by the authors, apparently rare in the area.

36. **T. xylodes** (Kze.) Ching. Collected by Strachey from Almora and Nainital at an altitude of 5000 to 7000 ft. (1524 to 2133 m.); not collected by the authors.

37. **Cyclosorus dentatus** (Forsk.) Ching. Common in ravines descending down to the plains. Collected from Bhowali-Bhim Tal Road and Bhujia Ghat.

38. **Athyrium schimperi** Moug. Common in the forest towards Land's End. The species has a thin extensively creeping rhizome.

39. **A. falcatum**[1]. A small-sized species occupying moist but comparatively open localities on Bhowali-Bhim Tal Road and Bhujia Ghat.

40. **A. tenuifrons** Moore. Not observed by the authors, but collected by Strachey at 4000 to 7000 ft. (1219 to 2133 m.) altitude.

41. **A. rupicola** (Hope) C. Chr. Reported by Strachey ; not collected by the authors in the area investigated.

42. **A. pectinatum** Wall. Grows in open places at low altitudes. Frequently observed on way to Bhowali.

43. **A. oxyphyllum** Hook. Not collected by the authors in the area investigated.

44. **A. longifolium** Don. Not collected by the authors ; apparently rare.

45. **Diplazium polypodioides** Bl. An inhabitant of moist habitat of ravines. Collected once from a ravine along Nainital-Bhowali Road.

46. **D. japonicum** (Thunb.) Bedd. Collected by Strachey but not seen by the authors ; apparently rare.

ASPLENIACEAE

47. **Asplenium varians** (Wall.) Hk. et Grev. An inhabitant of moist boulders on way to Lari Kanta (alt. 7500 ft.=2286 m.) and Land's End.

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[1] Identification provisional.

48. **A. unilaterale** Lamk. Rare in the area.

49. **A. alternans** Wall. Exceedingly common on rocks and roadsides between 4000 and 6000 ft. (1219 to 1829 m.) altitude. Collected from Nainital, Bhim Tal, Bhowali, and Dogaon.

50. **A. exiguum** Bedd. Reported by Strachey from Nainital.

POLYPODIACEAE

51. **Goniophlebium microrhizoma** Clarke. A very common epiphyte at Nainital level.

52. **Polypodium lachnopus** Wall. A common epiphyte as well as on rocks; generally an associate of *Goniophlebium microrhizoma.* The fronds are covered with scales which are similar to those on the rhizome. In certain well-protected localities the fronds may attain a length of 2 to 3 ft. (61 to 91 cm.).

53. **Pleopeltis kashyapii** (Mehra) Alston & Bonner. An exceedingly common epiphyte at Nainital level and extends farther east.

54. **P. linearis** Thunb. Grows between 4000 and 6000 ft. (1219 to 1829 m.) alt. as a lithophyte and flourishes equally well as an epiphyte. Collected from Khurpa Tal.

55. **Lepisorus excavatus** var. **scolopendrium** (Ham.) Ching. It is a common epiphyte around Nainital; under shaded conditions it extends its rhizome horizontally beyond the trunk to expose its foliage fully, while the long wiry roots are directed back towards the moss-laden trunks for the absorption of water.

56. **Pyrrosia flocculosa** (Don) Ching. Most common epiphyte at low altitudes in several localities such as Bhim Tal, Dogaon, and Bhujia Ghat.

57. **Pyrrosia** sp. Grows in association with *P. flocculosa* but strongly differs in having more narrow, linear lanceolate and hairy fronds. On older leaves the hairs are generally brown in colour.

58. **Microsorium membranaceum** (Don) Ching. A common fern between 5000 and 7000 ft. (1524 to 2134 m.) growing on moist rocks.

59. **Phymatodes oxyloba** (Roxb.) Ching. It is an important lithophyte of the area. Collected on way to Bhowali, where it was found covering the entire aspect of a big boulder. The plants vary in size from 4 to 8 in. (10 to 20 cm.) in length.

60. **Drynaria mollis** Bedd. A common epiphyte on oak trees at 7000 to 9000 ft. (2134 to 2743 m.). Dimorphic fronds and the creeping rhizome round the tree trunks are the outstanding characters. Collected from Cheena Peak and Laria Kanta.

61. **Loxogramme involuta** Don. Collected only in one locality as an epiphyte on way to Cheena Peak. Not common.

SUMMARY

The present account on the ferns of Nainital has been incidental to the authors' cyto-taxonomic investigations in some Himalayan fern species complexes. During a short visit to Nainital in July 1959, 47 species were gathered from various habitats. The foregoing list of species also includes fourteen species that have not been found by the authors in Nainital but were reported to occur in Nainital by Strachey (1906). It may be pointed out that Strachey has mentioned only 24 species for Nainital. On the findings up-to-date, therefore, 61 species of ferns occur in Nainital. These have been arranged according to Copeland's system of classification.

ACKNOWLEDGEMENTS

The authors are deeply indebted to Prof. P. N. Mehra, D.SC., F.N.I., and Mr. R. S. Chopra for encouragement and keen interest. They are grateful to Rev. Fr. H. Santapau for kindly going through the manuscript and to Prof. R. C. Ching for the adequate literature and help in identification.

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Critical Notes on the Orchidaceae of Bombay State

IV. THE GENUS *DENDROBIUM* SW.

BY

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(*With ten plates*)

[*Continued from Vol.* 57 (2) : 269]

DENDROBIUM Sw.

The generic name *Dendrobium* is derived from the Greek words ' dendron'=tree, and 'bios'=life, in allusion to the epiphytic habit of the species.

Dendrobium Sw. in Nov. Act. Soc. Sc. Upsal. 6 : 82, 1799, nom. cons.; Endl. Gen. Pl. 192, 1837 ; Lindl. in Bot. Reg. 46, 1844, et in Journ. Linn. Soc. 3 : 1, 1858 ; Benth. & Hook. f. Gen. Pl. 3 : 498, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 172, 1889 ; Hook. f. Fl. Brit. Ind. 5 : 710, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 38, 1898 ; Duthie, ibid. 9 (2) : 84, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 306, 1905 ; Kränzl. in Pflanzen. 45 : 25, 1910 ; Schlecht. Orchid. 246, 1927 ; Holttum, Rev. Fl. Malaya 1 : 258, 1953. *Oeraia* Lour. Fl. Coch. 518, 1790. *Callista* Lour. Fl. Coch. 519, 1790 ; O. Kuntze, Rev. Gen. Pl. 2 : 652, 1891 ; Kränzl. 313. *Desmotrichum* Bl. Bijdr. 329, 1825 (non-Kuetz. 1845) ; Kränzl. 343.

Perennial *epiphytes*. *Rhizomes* short or long, simple or branching, with pseudobulbs. *Pseudobulbs* simple, uni- or multi-nodal, from sheathing cataphylls, which, when old and dry, appear as fibrous threads at the nodes. *Leaves* deciduous or persistent, either 1 or 2 at the top of the pseudobulb or many and bifarious throughout the stem. *Flowers* solitary, in fascicles or in racemes, axillary, or from the scarious clusters of bracts at the apex of the pseudobulb. *Sepals* subequal, spreading, erect or connivent ; lateral sepals more or less connivent on the foot of the column forming a mentum ; rarely mentum absent. *Petals* equalling the dorsal sepal or larger, free. *Lip* articulate with the foot of the column, or rarely connate, entire or 3-lobed. *Column* free, short, the anterior part with a large depression, occupied by the stigma, anterior side arms short, entire or bilobed ; foot long or short, or rarely absent, more or less hollowed on the front, nectariferous at the base; rostellum small, transversely lamellate. *Anther* subglobose or conical, anterior part retuse or toothed, 2-celled, the stalk short subulate or filiform; pollinia 4, in pairs, subequal, the external ones slightly smaller. *Capsules* ovoid or obovoid.

In a broad sense Schlechter has estimated the total number of species to be in the neighbourhood of 900. This genus occurs almost exclusively in the Old World. It is distributed from India and Ceylon to southern China and Japan, southwards through Malaysia far into the Pacific and to Australia and New Zealand.

This very large and polymorphic genus has been variously divided into subgenera and sections by various authors. Kränzlin in his monumental monograph of the genus divides it into 10 subgenera. All our Bombay species (except one) are included under the first subgenus *Eudendrobium*; *D. lawianum* Lindl. goes with peloric forms under *Aclinia.* Most modern authors divide the genus into sections; we follow them. However for *D. lawianum* Lindl. we follow Lindley in reinstating the section *Aclinia.* The name of the section containing the type species, *D. crumenatum* Sw. (sect. *Eudendrobium*) must be changed to *Dendrobium* sect. *Dendrobium,* according to the Art. 22 of the Code.

Type species: *D. crumenatum* Sw.

KEY TO THE SPECIES OF *DENDROBIUM* OF BOMBAY

1. Rhizome distinct, creeping; leaf 1, from top of pseudobulb; flowers 1 or 2 borne on the top of the pseudobulb .. *macraei*
1. Rhizome not distinct; leaves several, bifarious; flowers many in racemes or in pairs, rarely solitary:
   2. Stems usually tufted forming small ovoid pseudobulb, rarely elongate; flowers in slender racemes, rarely solitary:
      3. Stems long, much branched; lip undivided or obscurely 3-lobed .. *herbaceum*
      3. Stems simple, often reduced to small pseudobulb; lip distinctly 3-lobed:
         4. Small plants with crowded, ovoid pseudobulbs; petals not broader than dorsal sepal:
            5. Leaves fleshy, coriaceous; peduncles very short, some-

what thick ; racemes arising almost directly from apex of pseudobulb ; midlobe of lip acute .. .. *peguanum*

5. Leaves thin, membranous ; peduncles 4-5 cm. long, filiform, slender ; midlobe of lip rounded, obtuse or retuse :

6. Lip pink with deep red-purple veins, irregularly crenulate, broader across lateral lobes than the midlobe ; midlobe small irregularly crenulate, truncate or subretuse .. *microbulbon*

6. Lip pale yellow or yellowish-green, ± suffused with pink, equal to or narrower than midlobe ; midlobe of lip suborbicular, with 2 rows of stiff, glandular hairs on margin, rounded or subemarginate *mabelae*

4. Larger plants with elongate pseudobulbs (rarely uninodal) ; petals much broader than the dorsal sepal :

5. Flowers cream-coloured, about 1.5 cm. across ; lip about 8 mm. long, the disc with pale green hairs all round ; midlobe of lip somewhat quadrate-rounded .. *ovatum*

5. Flowers pure white, or tinged with pink, or often strongly rosy-pink, about 2.5-4 cm. across ; lip 23-30 mm. long, the disc with pale yellow hairs at its base and apex only ; midlobe of lip broadly ovate, or ovate-oblong or rarely subflabellate .. *barbatulum*

2. Stems elongate, clavate or nodose ;

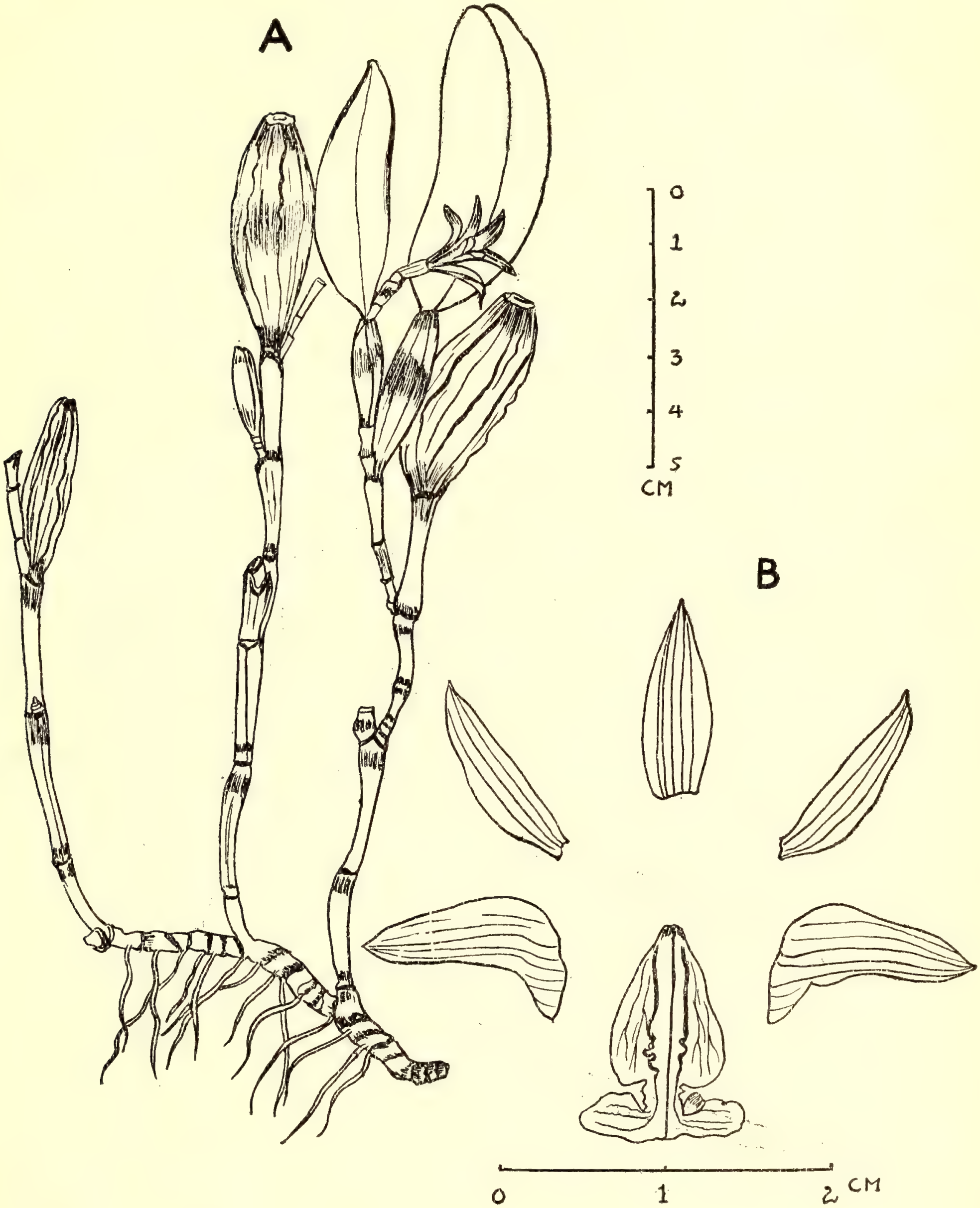
flowers in lateral pairs or fascicles, rarely solitary :

3. Flowers zygomorphic ; mentum distinct ; column with a distinct foot :
    4. Flowers pale cream-yellow, lip with red or purple nerves ; mentum about half as long as dorsal sepal or longer ; lip entire or hardly lobed, minutely serrate, fimbriate, hairy .. *macrostachyum*
    4. Flowers pale watery-green, lip pale yellowish on the inside ; mentum less than half the length of dorsal sepal ; lip 3-lobed ; lateral lobes broad, obovate-oblong rounded, ascending ; midlobe deflexed and contracted inwards at the base slightly ciliate .. .. .. *aqueum*
    4. Flowers white or suffused with pale rose, lip with a yellow patch at the base ; mentum very small ; lip subentire, obscurely 3-lobed ; lateral lobes small forming a small pouch at the base ; midlobe spreading, oblong-round, puberulous .. *crepidatum*
3. Flowers subregular ; mentum absent ; column without a foot .. .. *lawianum*

ENUMERATION OF THE SPECIES OF *DENDROBIUM* OF BOMBAY STATE

1. **Dendrobium macraei** Lindl. Gen. Sp. Orch. 75, 1830, et in Journ. Linn. Soc. 3 : 6, 1859; Dalz. & Gibs. Bomb. Fl. 260, 1861 ; Hook. f. 714, (partim) ; Grant, Orch. Burma 104, 1895, (partim) ; King & Pantl. 61, t. 86 ; Gammie in Journ. Bombay nat. Hist. Soc. 16 : 566, 1905 ; Cooke, Fl. Pres. Bomb. 2 : 680, 1807 ; Brühl, Guide Orch. Sikk. 66, 1926 ; V. Narayanaswami in Journ. Ind. Bot. Soc. 25 : 215, 1946. *D. nodosum* Dalz. in Hook. Journ. Bot. 4 : 292, 1852. *D. rabani* Lindl. in Journ. Linn. Soc. 3 : 7, 1858. *D. pardalinum* Reichb. f. in Gard. Chron. 11 : 230, 1885. *Callista macraei* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 655, 1891. (See Plate XVI)

Stems long, creeping, annulate, profusely branching ; branches polynodal, more or less trigonous or terete, smooth, shining, yellowish-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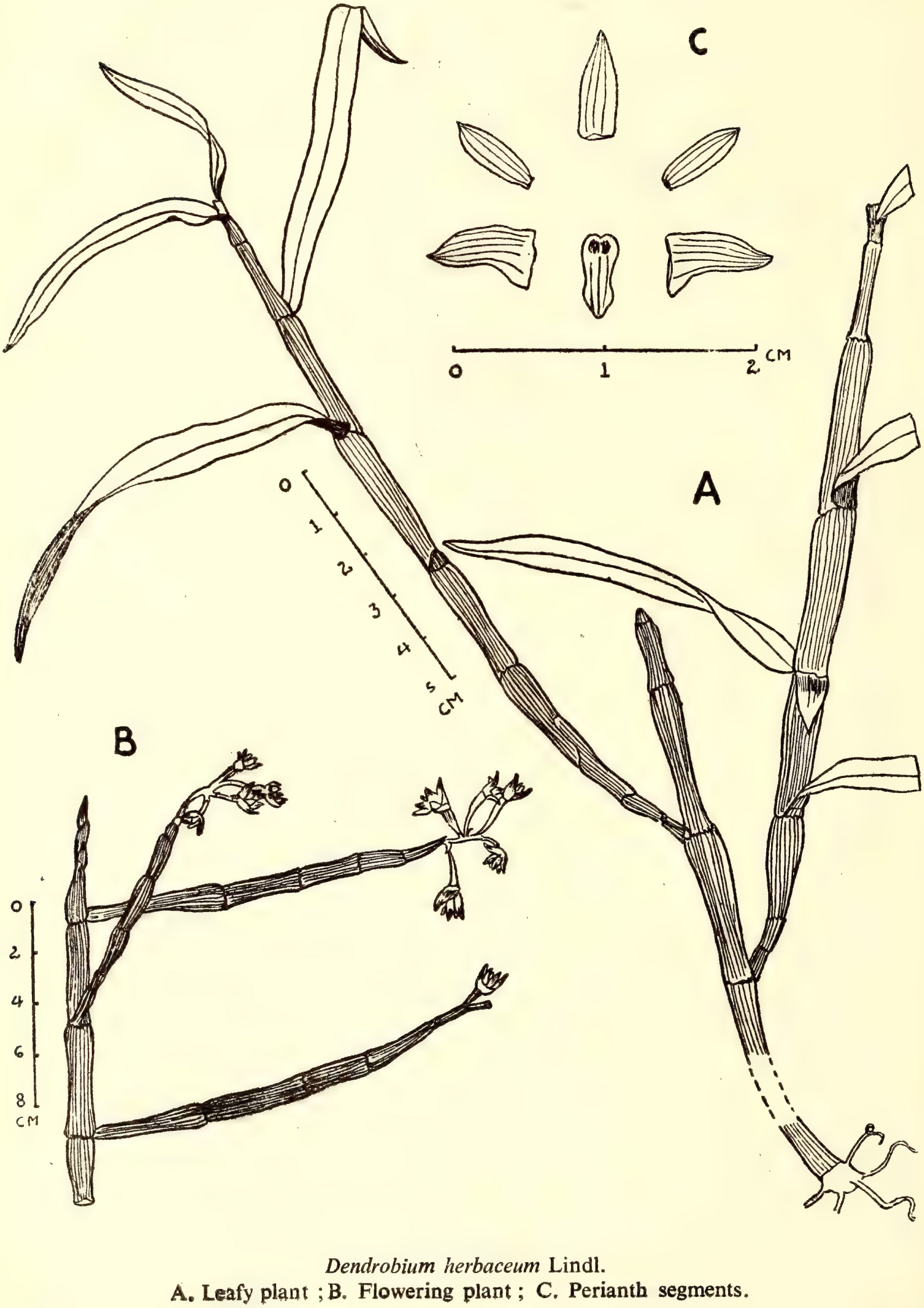
Dendrobium macraei Lindl.
A. Whole plant ; B. Perianth segments.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Dendrobium herbaceum Lindl.
A. Leafy plant ; B. Flowering plant ; C. Perianth segments.

brown, ending in pseudobulbs. *Pseudobulbs* 2-8×0.5-2 cm., linear-oblong, fusiform, green or yellow, terete or compressed, and sulcate when dry. *Leaf* 4-10×1-2.5 cm., solitary, sessile, very coriaceous, 1-nerved, ovate-lanceolate or oblong-elliptic, acute, obtuse or rarely sub-retuse. *Flowers* one or rarely two, lasting for less than a day, from the axil of the leaf, on a stalk 6-7 mm. long, which is sheathed at the base with several scarious bracts. *Floral bracts* at the base of the ovary about 3 mm. long, oblong-lanceolate. *Ovary* with the short *pedicel* 5-6 mm. long, subclavate, pale yellow, ridged, separated from the stalk by the bract. *Sepals* 12 × 4 mm., white, very slightly suffused with pink and yellow, ovate or ovate-oblong, acute, faintly 5-nerved ; mentum blunt, slightly retuse, at right angles to the ovary, about 4 mm. long, pale creamy-yellow with a few reddish spots at the back towards the apex. *Petals* equalling or slightly shorter and narrower than the sepals, similar to the latter, faintly 3-nerved. *Lip* obovate in outline, about 13 mm. long, white speckled with red on both the surfaces, 3-lobed ; lateral lobes 10-11 × 2 mm. erect, narrowly oblong, obtuse ; the 2-winged apex separated from the lateral lobes by 1-2 mm. long subplicate claw, the wings erect in the flower, about 1 cm. across, oblong-elliptic, truncate or rounded at the apex ; the 2 lamellae reddish, along the centre to the end of the lateral lobes, much plicate. *Column* 2 × 1.5 mm., oblong, yellowish white, irregularly serrulate on top (i.e. margin of the clinandrium). *Stigmatic surface* broad, oblong-orbicular, margined with red. *Anther* small, pale yellowish white.

Leaves : persistent throughout the year. *Flowering :* July to August.

Occurrence in Bombay State : W. GHATS : Mahableshwar, *Cooke* ; Koina Valley, *Cooke* ; *Birdwood* ; Ramghat, *Dalzell & Gibson.* N. KANARA : Joida Kumbelli Mines, about 12-15 miles from Supa, *Kapadia* 2575-2827 ; Sampkhand, *Woodrow* ; Castle Rock, *Kapadia* 2824-2827 ; Gundh Anshi, *Pirson* ; Siddhapur, *V. Patel* 1849 ; *Kapadia* 2362-2364 ; Anmod, *Kapadia.*

Distribution : *India* : Sikkim, Khasia Hills, W. Ghats of Bombay State and S. India, N. Kanara. *World* : Ceylon, India, and Burma.

Notes : At Anmod in N. Kanara, this species is locally known as ‘ Ruttun-purush ’ and is much valued in the local market, where it is sold for a high price ; this plant is extensively used by the local population for making a much-valued ‘ Halwa ’ (sweet preparation).

This species has been included by Kränzlin, Fischer (*Fl. Pres. Madr.* 1412, 1928), and Blatter & McCann (in *Journ. Bombay nat. Hist. Soc.* 35 : 265, 1931) under the genus *Desmotrichum* Bl. and has been considered to be synonymous with *Desmotrichum fimbriatum* Bl. V.

Narayanaswami has elaborately discussed the problem and has conclusively shown that : '(1) *Desmotrichum* Bl. may perhaps be retained as a sectional name for a very limited group of *Dendrobia*, consisting usually of a primary creeping stem with several polynodal branches, each branch ending in a monophyllous pseudobulb and with a solitary axillary flower, but it is preferable to sink it under *Dendrobium.* (2) *Dendrobium* of Swartz is a sufficiently comprehensive genus and also embraces the species described under *Desmotrichum* Bl. There is not much difference to distinguish the latter generically from the former. This view has been accepted by Blume himself, and *Desmotrichum* has been included by him under *Dendrobium.* (3) *Dendrobium macraei* Lindl. is the valid name for the widely distributed Ceylon species and includes under it and is conspecific with *Den. nodosum*, *Den. rabani*, *Den. pardalinum.* It is entirely different from *Des. fimbriatum* Bl. (4) *Den. plicatile* Lindl. is the earliest valid name for *Des. fimbriatum* Bl. and is conspecific with *Den. flabellum* Reichb. f., *Den. kunstleri* Hook. f., *Den. binnendijkii* Reichb. f., and *Den. fimbriatum* Lindl. (5) Confusion in synonymy originated in the Fl. Brit. Ind., wherein under *Den. macraei* Lindl. the following were included, namely *Des. fimbriatum* Bl., *Den. flabellum* and *Den. binnendijkii* Reichb. f. (6) In the *Pflanzenreich* 3 separate species of *Desmotrichum* were created from the species mentioned in (4) above, to one of which *Den. macraei* Lindl. was reduced. (7) In the Indian floras, published subsequent to the Fl. Brit. Ind. the changes introduced in *Pflanzenreich*, were adopted apparently without scrutiny.'

2. **Dendrobium herbaceum** Lindl. Bot. Misc. 69, 1840, et Misc. 58, 1844 ; Hook. f. 719 ; Prain, Beng. Pl. 1006, 1903 ; Gammie 17 : 32, 1906 ; Cooke 682 ; Kränzl. 72 ; Haines, Bot. Bih. Or. 1173, 1922 ; Fischer, Fl. Pres. Madr. 1416, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 263, 1931. *D. ramosissimum* Wight, Icon. 5 (1) : 6, t. 1648, 1851 ; Dalz. & Gibs. 261. (See Plate XVII)

Large, pendulous or erect epiphytic herbs. *Pseudobulbs* 30-90 cm. long, much branched, 7-15 mm. thick, thin at the base, thickening upwards ; primary ones naked ; internodes 3.5 cm. long, deep purple-brown, or brown, or brown-yellow, shining and polished, deeply ridged and furrowed ; lateral branches leafy or not at the time of flowering, green or yellowish green, sheathed. *Leaves* 3-11 × 0.4-1.3 cm., sessile, sheathing at the base, caducous, alternate, distichous, linear-oblong or linear-lanceolate, acute or subobtuse, entire, glabrous. *Inflorescence* appearing after leaf-fall, short, 2-5-flowered, terminal. *Peduncles* 7-15 mm. long, brownish green, slender, glabrous, sheathed at the base ; sheaths very small, membranous, oblong, subacute, entire, translucent, glabrous. *Flowers* 7 × 10 mm., greenish white, pedicellate, bracteate. *Bracts* 3 × 1 mm., persistent, membranous, translucent, semi-amplexicaul, brownish white, ovate-oblong or oblong, acute or subobtuse, entire, glabrous, 1-nerved. *Pedicels* with ovary 12 mm. long, about 0.5 mm. in diam., pale green, glabrous. *Sepals* greenish white, oblong-lanceolate, subacute, with a minute mucro just below the apex, entire, glabrous, 3-5-nerved ; dorsal sepal 7×2.5 mm. ; lateral ones 7×2.5 mm., 4 mm. broad at the base, subfalcate, connate along the foot, forming the mentum ; mentum 3-4 mm. long, broadly funnel-shaped, rounded, enclosing the lip at the base. *Petals* 6×2 mm., greenish white, linear or linear-oblong, acute, entire, glabrous, 3-5-nerved. *Lip* 5×2.5 mm., greenish white, curved at the base, oblong-ovate in general outline, constricted somewhat below the middle, entire, 3-5-nerved, obscurely 3-lobed ; the lateral lobes narrow, obsolete, slightly turned upwards along the margins ; terminal lobe ovate or ovate-triangular, obtuse. *Column* 1×1 mm., greenish white, the lateral arms produced above into broad subentire obtuse wings, which completely cover the anther at the back except for a narrow linear-oblong space ; from the base of the opening a short, filiform process is given out to which the back of the anther is attached ; foot 2-3 mm. long, pale green, curved, obtuse. *Anther* white, 1.25×1 mm., oblong-suborbicular, retuse. *Stigmatic surface* green, rounded, deep-seated in the column ; rostellum white, narrowly transversely-oblong. *Capsule* 1.8×0.4 cm., narrowly fusiform, broad at the apex, sharply tapering at the base into a long pedicel, brownish green, somewhat 3-angled with yellowish ribs.

Leaves : June to September. *Flowering* : September to October. *Fruiting* : November to April.

Occurrence in Bombay State : KONKAN : *Dalzell & Gibson* ; Bombay, cultivated, *Kapadia* 1623-1628. W. GHATS : Mahableshwar, *Woodrow* ; *Cooke* ; *Acland* ; *Kapadia* 599, 1925 ; *Santapau* 23440. DECCAN : Manched — Bhimashankar, *Kapadia* 1451-1456. N. KANARA : Anmod, *Sedgwick*.

Distribution : Parasnath, Bengal, Godavari district, Konkan, W. Ghats of Bombay, Mysore and Madras States from 600 to 1200 metres.

Notes : Gammie mentions that this species flowers in the hot weather ; this seems to be very unusual, and we have found it in flower only in the latter part of the monsoon.

3. **Dendrobium peguanum** Lindl. in Journ. Linn. Soc. 3 : 19, 1859. *D. pygmaeum* Lindl. Gen. Sp. Orch. 85, 1830, et Bot. Reg. misc. 62, 1844 ; Hook. f. 717 ; Grant 116 ; King & Pantl. 43, t. 58 ; Kränzl. 83 ; Haines 1173 ; Brühl 55 (non Smith ex Rees, 1808 ; nec A. Cunn. ex Hook. 1836). *Callista pygmaea* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 655, 1891. *Dendrobium microbulbon* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 262, (partim) f. 7, 1931, (non A. Rich. 1845). (See **Plate XVIII**)

Pseudobulbs 1-6 cm. long, ovoid-conical to oblong-ovoid, stout, up to 2 cm. in diam., usually 2-4-noded, sheathed, pale green or yellowish green ; sheaths membranous with prominent veins. *Leaves* 2-4, coriaceous, 2.5-5 × 0.6-2 cm., sessile, broadly elliptic or elliptic-oblong, subacute or obtuse, 1-nerved. *Racemes* 1-5, almost directly arising from the apical part of the pseudobulb, with a few scarious, sheathing bracts at the base, 1-many-flowered, up to 7 cm. long. *Flowers* about 12 mm. long, shortly pedicellate, bracteate, faintly perfumed. *Bracts* 5 mm. long, dry, membranous, persistent, narrowly linear-lanceolate, entire, 1-nerved. *Ovary* with pedicel about 6-7 mm. long, curved, pale green or purplish. *Sepals* 8 × 2-2.5 mm., pale green or faintly suffused with pink, oblong, slightly dilated in the middle, sharply acute, entire, 3-nerved ; mentum 4-4.5 mm. long, narrowly conical, curved, subacute. *Petals* 8 mm. long, white, faintly 3-nerved, subacute, obspathulate, 2 mm. broad a little behind the apex, tapering to 4 × 1 mm. claw. *Lip* 8 mm. long, pale green ; midlobe suffused with amethyst or purplish, 3-lobed, with a small, 1-2 mm. long claw, obovate-deltoid in outline ; lateral lobes erect, more or less connivent over the column, 5 × 1-1.5 mm., narrow, with a straight grooved disc in between continuing from the claw up to the midlobe, veins faint ; midlobe 2-2.5 × 2 mm., slightly decurved, more or less orbicular or broadly triangular in outline, acute (often appearing retuse in pressed specimens), the margins crenulate, curving upwards. *Column* 3 × 2 mm., narrowly oblong, white ; foot 3 mm. long, conical, the base with a small pouch. *Anther* 1.25 × 1.25 mm., pale amethyst, its anterior lip minutely pectinate ; pollinia 1 mm. long, golden-brown. *Capsules* about 7 × 4-5 mm., deep chocolate-brown, ribbed, on a very short pedicel.

Leaves : June to October. *Flowering* : October to December. *Fruiting* : December to March.

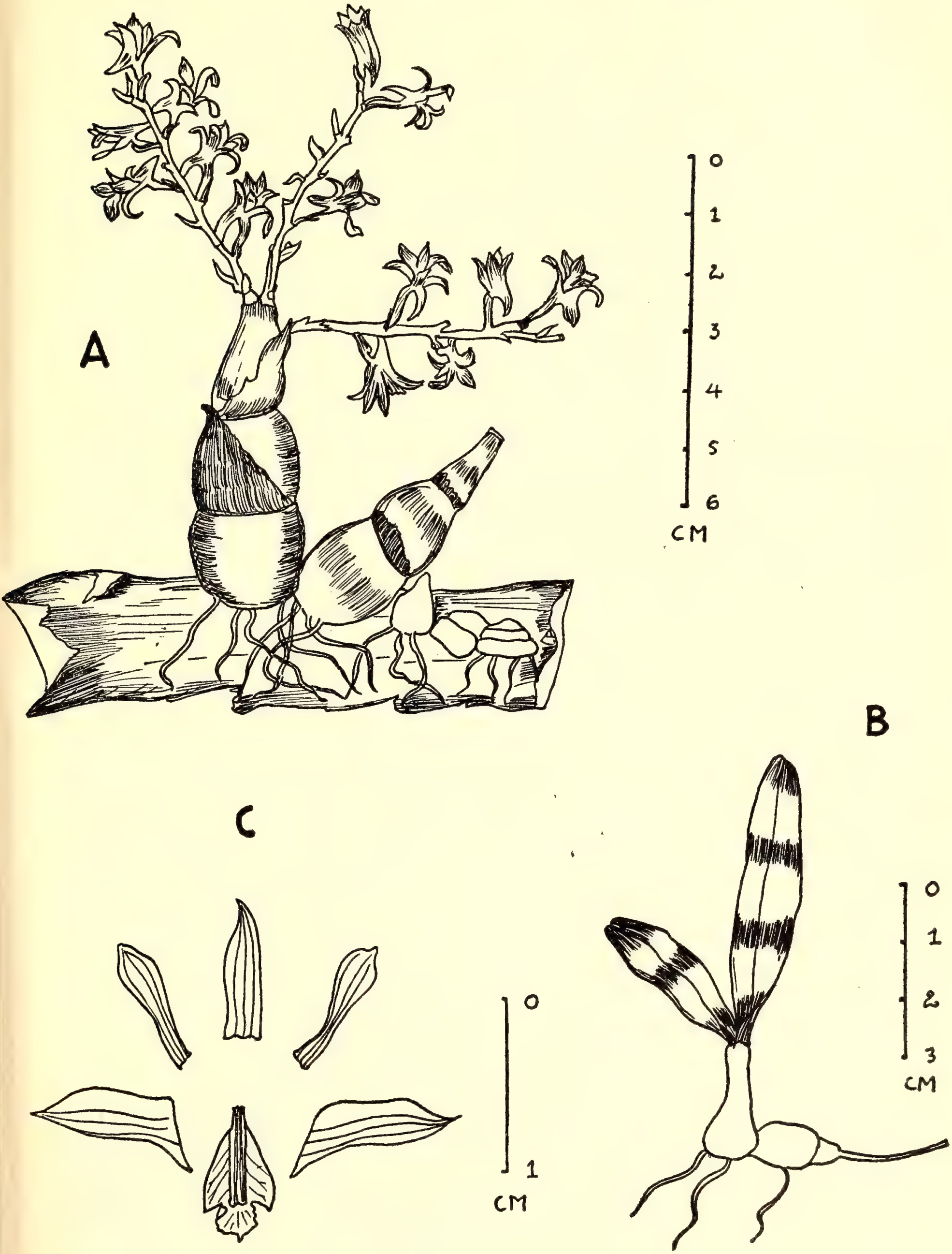
Occurrence in Bombay State : DANGS : Pimpri, *Kapadia* 1600-1601 ; Ahwa, *Kapadia.* KONKAN : Thana, cultivated, *Kapadia* 1104 ; Atgaon-Tansa, *Kapadia* 724-726, 1635-1636. W. GHATS : Kasara-Igatpuri, *Kapadia* 1375. N. KANARA : Dandeli, *Kapadia* 1665 ; Dharwar, *Sedgwick* 3788.

The plant has been recorded for the first time from Bombay State.

Distribution : *India* : Sikkim Himalaya, Jaspur, Dangs, Konkan, W. Ghats and N. Kanara. *World* : India and Burma.

Notes : We have usually found this species epiphytic on *Tectona grandis* L. f.

This species is similar to *D. microbulbon* A. Rich. and may be confused with it. However, it can easily be distinguished by its broader, coriaceous leaves and the smaller, compact, dense racemes arising almost directly from the apical part of the pseudobulb. Blatter & McCann seem to have mixed up the two species, as evidenced by their fig. 7, and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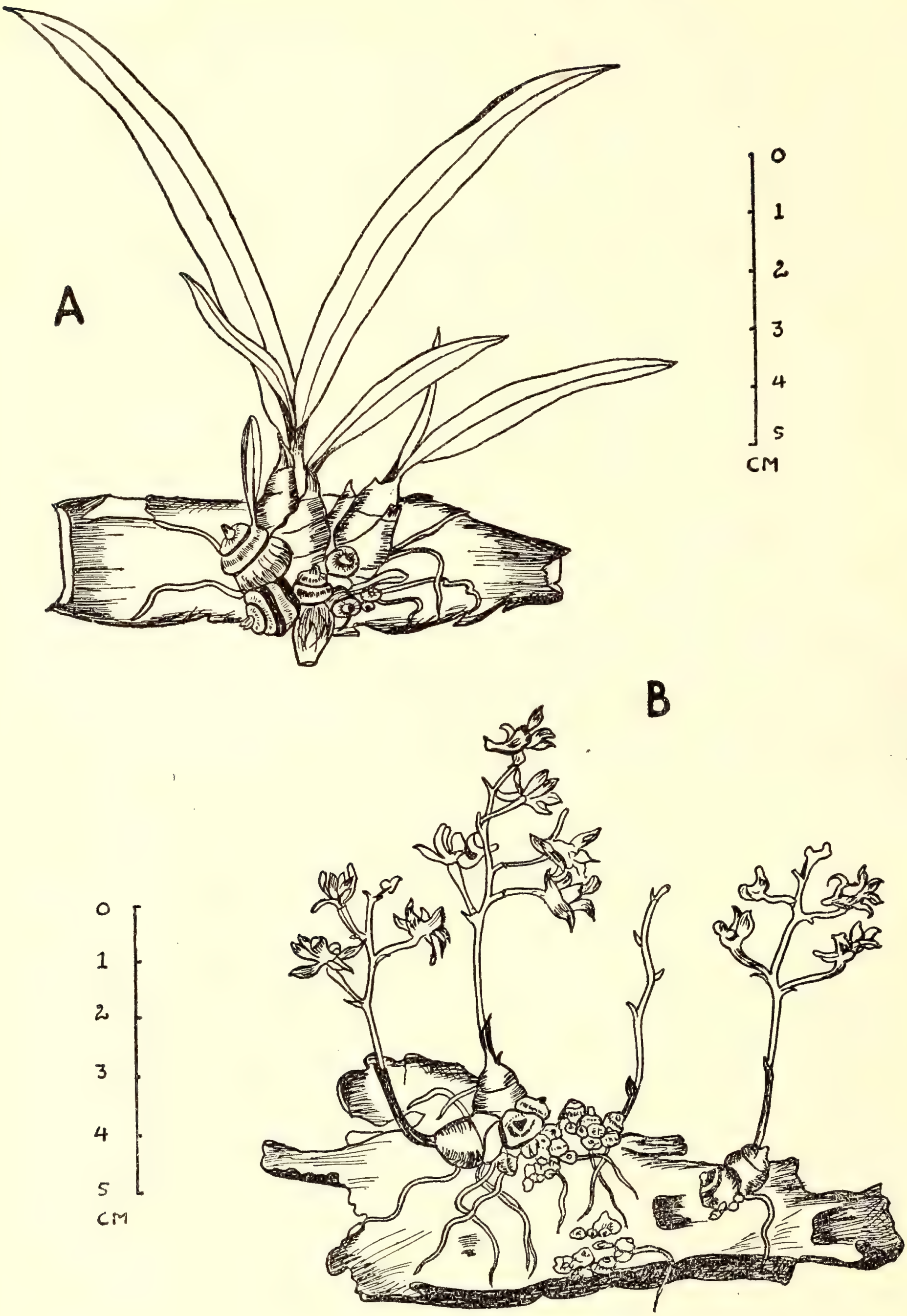
Dendrobium peguanum Lindl.
A. Flowering plant; B. Leafy plant; C. Perianth segments,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Dendrobium microbulbon A. Rich.
A. Leafy plant ; B. Flowering plant.

also by the citation of *Sedgwick* 3788 under *D. microbulbon* A. Rich. ; Sedgwick's plant clearly belongs to *D. peguanum* Lindl. (=*D. pygmaeum* Lindl.).

This species goes under the name of *D. pygmaeum* Lindl. in our Indian floras, with *D. peguanum* Lindl. as a synonym. But *D. pygmaeum* Lindl. (1830) is a later homonym of *D. pygmaeum* Smith (1808) ; the correct name for the plant is, therefore, *D. peguanum* Lindl.

4. **Dendrobium microbulbon** A. Rich. in Ann. Sc. Nat. ser. 2, 15 : 19, t. 8, 1841 ; Lindl. in Bot. Reg. 61, 1844, et Journ. Linn. Soc. 3 : 19, 1859 ; Dalz. & Gibs. 261 ; Hook. f. 716 ; Gammie 16 : 567, 1905 ; Cooke 681 ; Kränzlin 29, f. 3 T ; Fischer 1415 ; Blatt. & McC. 261 (partim, non f. 7). *D. humile* Wight, Icon. 5 (1): 5, t. 1643, 1851. *D. crispum* Dalz. in Hook. Journ. Bot. 4 : 111, 1852. *Callista microbulbon* (A. Rich.) O. Kuntze, Rev. Gen. Pl. 2 : 255, 1891. (See Plate XIX)

Small *epiphytes. Pseudobulbs* 1-2 × 1 cm., crowded, mauve-brown, leafless at the time of flowering and covered with a network of fibres formed by the decayed membranous sheaths, conical, 1-3-jointed. *Leaves* caducous, appearing in the monsoon before the flowers, rarely with them ; 2-14 × 0.3-1.3 cm., sessile, sheathing at the base, thin, linear-lanceolate to oblong-lanceolate, acute, entire, 1-nerved. *Inflorescence* in racemes 1.5-10 cm. long, erect, 1-3 arising from the terminal portion of the pseudobulb ; peduncles 1-6 cm. long, purplish brown, slender with a few oblong, acute, membranous pale brown sheaths. *Flowers* 10-12 × 7-8 mm., faintly perfumed, pedicellate. *Bracts* 2-3 × 1 mm. scaly, membranous, light brown, semi-amplexicaul, ovate-lanceolate, acute, entire, glabrous, 1-nerved. *Pedicel* with *ovary* 7-10 mm. long, pale brownish green, glabrous, faintly grooved above. *Sepals* white, entire, glabrous ; midnerve prominent, lateral pair faint ; dorsal sepal 4-6 × 2 mm., slightly shorter than the petals, erect, linear-lanceolate, rarely somewhat dilated a little beyond the middle, subacute ; lateral sepals 5-7 × 3-4 mm., spreading, broad at the base to form the mentum, falcate, acute or subacute, somewhat recurved ; mentum 6 × 4 mm., broadly infundibuliform at the mouth, narrowed to a fine, slightly upturned purplish apex, white flushed with purple downwards. *Petals* 8 × 1.5 mm., white, spathulate or oblanceolate, subacute or obtuse, entire, glabrous, faintly 3-nerved. *Lip* 4 × 5-5.5 mm., fused for about 1-2 mm. to the apex of the foot, curved, clawed 3-lobed ; claw narrow, 2 mm. long, pale mauve ; lateral lobes 5 × 1 mm., erect, more or less parallel with the column, linear, acute, entire, pale purplish green with many purple nerves on the inside ; midlobe 2 × 4 mm., white flushed with pink-purple with a few deeper-coloured nerves, transversely oblong-orbicular, truncate or slightly retuse at the apex, margins irregularly denticulate ; disc narrow, pale green, with 3 green parallel nerves, terminated by a slightly widened, free, 2-lobed callus. *Column* 2 × 1.5 mm., pale mauve-green, produced below into a 6 mm. long, pale purple, shallowly grooved foot ; lateral arms white, acute. *Anther* very small, pink-purple, suborbicular ; pollinia 4, waxy, linear, yellow. *Stigmatic surface* pale green lined with purple-brown. *Capsules* 10 × 6 mm., ovoid ; pedicels 3-5 mm. long, slender.

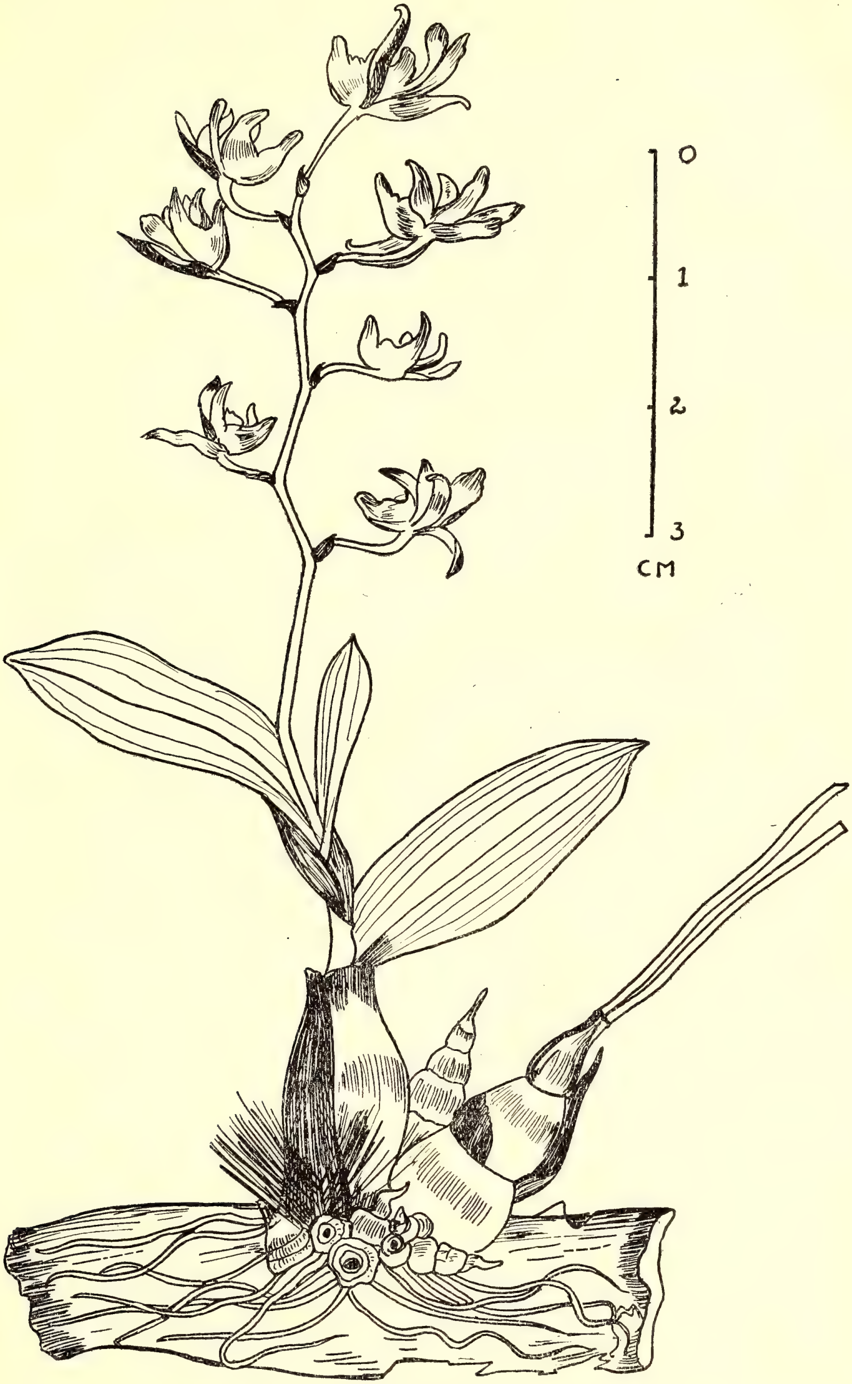
Leaves : July to October. *Flowering* : December to January. *Fruiting* : January to May.

Occurrence in Bombay State : KONKAN : *Stocks* ; Thana, *Bell.* W. GHATS : Kasara—Igatpuri, *Kapadia* 1374 ; Khandala, *Santapau* 253.30, 1037, 1439, 2452, 4363, 4600, 4740-4742, 5049 ; *Kapadia* 524, 1096-1097, 1235 ; Lonavla, *Kapadia* 536 ; Mahableshwar, *Cooke* ; *Sedgwick* ; *Ezekiel* ; *Millard* ; *Chibber* ; *J. Fernandez* ; *Santapau* 13134 ; *Kapadia* 596, 2057. DECCAN : Purandhar, *Santapau* 11456 ; *Kapadia* ; Bhimashankar, *Kapadia* 1447. N. KANARA : Amboli Ghat, *Bell.*

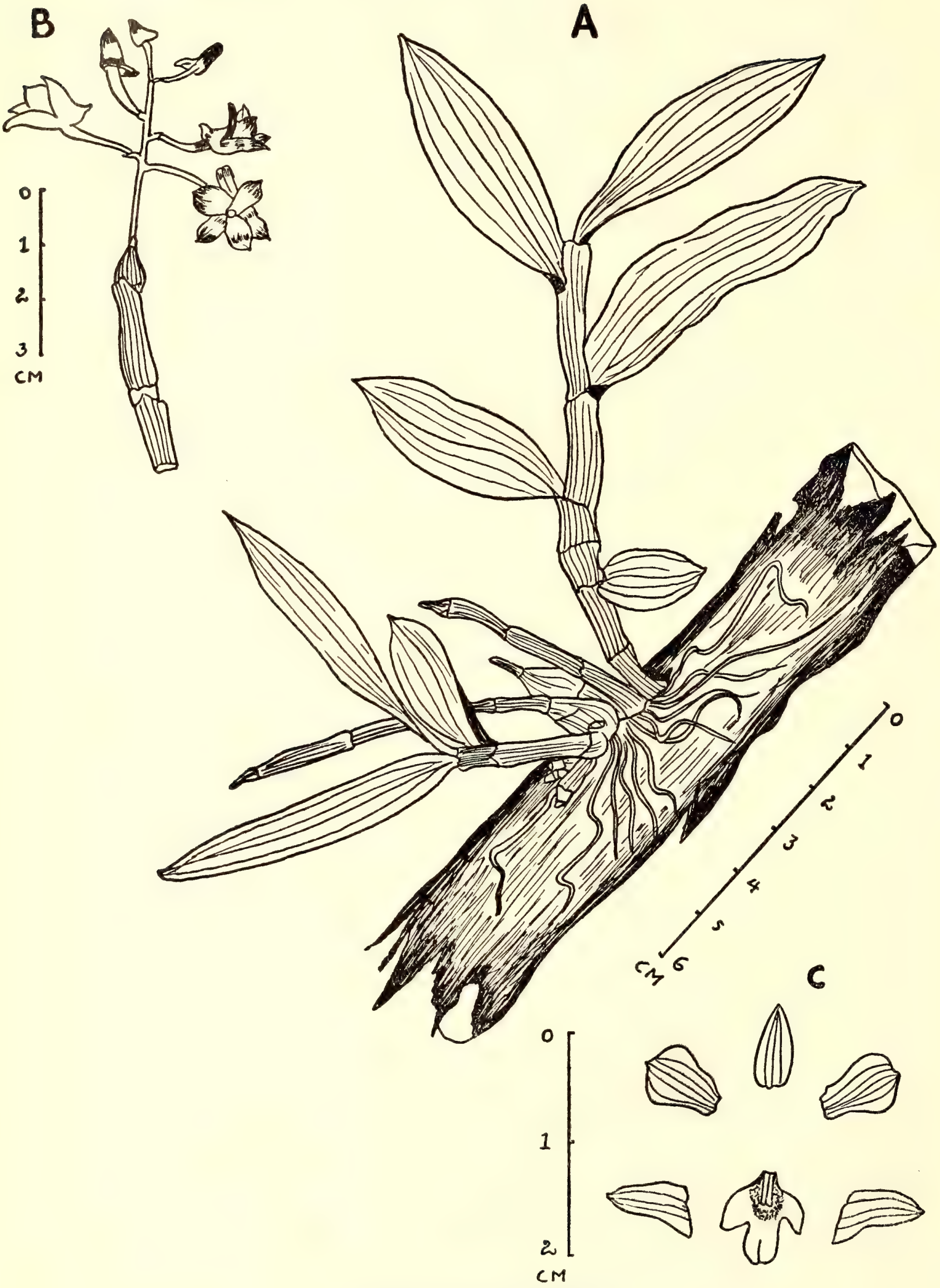
Distribution : Konkan, W. Ghats, Deccan, N. Kanara, Nilgiris, Anamalais.

5. **Dendrobium mabelae** Gammie in Journ. Bombay nat. Hist. Soc. 16 : 567, 1905 ; Cooke 681 ; Kränzl. 80 ; Blatt. & McC. 262. (See Plate XX)

Perennial, erect *epiphytes. Pseudobulbs* 1-4 × 0.7-2 cm., yellowish green, ovoid-conical, 1-4-noded, clothed with membranous sheaths, which on drying leave a network of fibres. *Leaves* 2-4, alternate, distichous, subcoriaceous, sessile, sheathing at the base and forming a short pseudostem above the pseudobulb, 3-8 × 0.4-0.8 cm., oblong or oblong-lanceolate, obtuse, entire, glabrous. *Inflorescence* 1-3 per plant, 5-12 cm. long. *Peduncle* slender, green, terete, straight or zigzag above, with 1-3 membranous, convolute, oblong, acute bracts. *Flowers* 1.5 × 1 cm., brown or brownish green, convolute, membranous, oblong, acute, entire, often serrulate above, glabrous, 1-nerved. *Pedicel* with *ovary* 8 mm. long, greenish white, slender, curved. *Sepals* subequal, white, entire, mucronulate, glabrous, 3-nerved, 8 × 3 mm. ; dorsal sepal broad, oblong-lanceolate ; lateral sepals 6 mm. ; broad at the base, spreading, sub-falcate, adnate along the foot, partially enclosing the lip to form an obovate, obtuse or subretuse, somewhat curved, 5 mm. long mentum. *Petals* 8 × 2.5 mm., white, linear-spathulate, mucronulate, glabrous, faintly 3-nerved. *Lip* 9 mm. long, obovate-suborbicular in outline, shallowly 3-lobed, curved ; lateral lobes 1 mm. long, white with faint, brownish red veins on the inside, or narrow, obtuse ; midlobe 3 × 6 mm. yellowish green or pure pale yellow, orbicular, emarginate, fringed with 2 rows of irregularly arranged, greenish white or yellow thick hairs ; disc yellowish green, extending as far as or a little beyond the lateral



Dendrobium mabelae Gammie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Dendrobium ovatum Kränzl.
A. Leafy plant ; B. Flowering plant ; C. Perianth segments.

lobes, with a free channelled bilobed ridge. *Column* 2 × 2 mm., greenish white ; foot 5 × 2 mm., obovate, obtuse or subretuse, yellowish on the outside, greenish white on the inside with pale red-brown short streaks. *Anther* 2-celled, yellowish green, oblong-orbicular, mobile on a thin process given out from the middle of the distal margin of the clinandrium ; pollinia 4, waxy, yellow, in pairs, oblong. *Stigmatic surface* pale-green, round, slightly broader than long. *Capsules* 2.5 × 0.7 cm., stalked, ovoid, ribbed ; pedicels 5 mm. long.

Leaves : June to October. *Flowering* : July to September, December. *Fruiting* : October to April.

Occurrence in Bombay State : W. GHATS : Igatpuri, *Kapadia* 1388 ; Panchgani, *Kapadia* 2046 ; Mahableshwar, *Santapau* 13165, 13227 ; *J. Fernandez* ; *Kapadia* 597-598, 995, 1938, 2062. N. KANARA : Belgaum Ghats, *Gammie* ; Londa, *Bhiva* ; Tinai Ghat, *Sedgwick* ; *Gammie* ; Anmod, *Sedgwick* 3370 ; *Kapadia* 1871, 1907 ; Castle Rock, *Bhiva* ; *Gammie* ; *Sedgwick* ; *Santapau* 17606 ; *Kapadia* 2800-2802.

Distribution : W. Ghats, N. Kanara, apparently endemic.

Notes : There seem to be 2 distinct forms. All the plants of the northern region of the W. Ghats (Igatpuri, Panchgani and Mahableshwar) begin to flower by the end of July and continue till September ; in the southern parts of the State (Castle Rock, Anmod) flowers do not appear till about the third week of December. Flowers of N. Kanara plants are slightly smaller, appearing without the leaves, and are pure white with a yellow lip. Except for these, we find no other differences in the flower structure to keep them apart.

6. **Dendrobium ovatum** (Willd.) Kränzl. in Pflanzenr. 45 : 71, 1910 ; Fischer 1416 ; Blatt. & McC. 262. *Cymbidium ovatum* Willd. Sp. Pl. 4 : 101, 1805 ; Graham, Cat. Bomb. Pl. 203, 1839. *Dendrobium chlorops* Lindl. in Bot. Reg. misc. 44, 1844; Dalz. & Gibs. 261 ; Bot. Mag. t. 5918, 1871 ; Hook. f. 719 ; Gammie 568, t. 1, 1905 ; Cooke 682. *D. barbatulum* Wight, Icon. 3 (2) : 10, t. 910, 1844-1845 (non Lindl. 1830). (See Plate XXI)

Pseudobulbs up to 50 cm. long, more or less uniformly mauve-brown, leafless at the time of flowering ; internodes one to many, 2-3.5 cm. long, longitudinally ribbed, the nodes slightly swollen. *Leaves* caducous, alternate, membranous, sheathing at the base, 5-11 × 1.2-3 cm., elliptic-oblong or oblong-lanceolate, acute, entire, glabrous, many-nerved. *Inflorescence* in racemes from the apical part of the pseudobulb, often up to 9, coming into flower at intervals ; peduncles with sheathing bracts at the base ; racemes about 3-15 cm. long, several-flowered, subpendulous. *Flowers* about 1.4-1.8 cm. across, cream-yellow (or pale nankin-coloured, according to Lindley) with pale green centres, pedicellate, bracteate. *Bracts* 2-3 mm. long, membranous, scarious, oblong, acute, sheathing. *Pedicel* with *ovary* about 17 mm. long, pale brown. *Sepals* 7-10 × 3-4 mm., pale creamy yellow, ovate-oblong, obtuse or mucronulate, entire, spreading, faintly 3-nerved, glabrous ; dorsal sepal more tapered towards the apex ; mentum 3-4 mm. long, pale green, more or less keel-shaped. *Petals* 7-9 × 5-6 mm. pale creamy yellow, obovate-oblong, suddenly widened just behind the minutely mucronulate apex, faintly 5-nerved, entire, glabrous. *Lip* 7-8 mm. long, pale creamy yellow, slightly clawed at the base, 3-lobed ; lateral lobes 4 × 2 mm. oblong, obtuse, erect and connivent over the column ; midlobe 4 × 3 mm., quadrate-oblong, rounded, subtruncate or subretuse at the apex, curved downwards from the lateral lobes, glabrous ; disc with a callus, subretuse, surrounded all over by pale green, soft hairs. *Column* about 2-3 mm. long, with a foot which is broad, tapering downwards, somewhat conical, curved, 3-5 mm. long. *Anther* about 1.5-2 mm. long, conical, obtuse, apiculate in front, yellowish. *Stigmatic surface* obovoid. *Capsules* about 18 × 8 mm. oblong-ovoid, purple, ribbed ; stalk 10 mm. long.

Leaves : June to September. *Flowering* : September to January. *Fruiting* : February to March.

Occurrence in Bombay : KONKAN : Salsette, *Hallberg* ; Tulsi Lake, *McCann* ; Bassein, *Ryan* ; Badlapur, *Kapadia* 1952 ; Thana, *Bell* ; *Kapadia* 1103 ; Tansa, *Santapau* 15399 ; *Kapadia* 1634 ; Pen-Campoli, *Gammie* ; Khardi, *Ryan* ; Wada range *Ryan* ; Matheran, *Birdwood.* W. GHATS : Kasara, *Kapadia,* 894-896 ; Kasara—Igatpuri, *Kapadia* 1369 ; Khandala, *Blatter & Hallberg* ; Mahableshwar, *Cooke* ; Phonda Ghat, *Ritchie.* N. KANARA : Gundh, *Kapadia* 896 ; Belgaum, *Kapadia* ; Ramanguli, *J. Fernandez* 2061 ; Gersoppa, *J. Fernandez* ; Yellapur, *Kapadia* 2037-2038 ; Ankola Belikeri, *Kapadia* 2169-2174 ; Karwar, *Blatt. Herb.* 233.19.

Distribution : Konkan, W. Ghats, N. Kanara, southwards along to S. India.

Notes : We have noted this species epiphytic on : *Tectona grandis* L. f., *Salmalia malabarica* Sch. & Endl., *Erythrina suberosa* Roxb., *Areca* trees in a plantation in N. Kanara, *Mangifera indica* L. It is usually found in open deciduous forests.

7. **Dendrobium barbatulum** Lindl. Gen. Sp. Orch. 84, 1830 ; Dalz. & Gibs. 261 ; Bot. Mag. t. 5918 (non t. 5444) ; Hook. f. 719 ; Gammie 17 : 31, t. 2. 1906 ; Cooke 682 ; Fischer 1416 ; Blatt. & McC. 262. (See Plate XXII)

Pseudobulbs 1.5-32 cm. long, leafless at the time of flowering, one- to several-noded, tapering at the apex ; nodes 1.5-2.5 cm. long, purplish brown, about 0.5-1 cm. thick with longitudinal whitish striations. *Leaves* 4.5-13 × 1.5-3.5 cm., alternate, distichous, sheathing at the base, lanceolate to ovate-lanceolate, acute, entire. *Inflorescence* terminal or lateral; racemes 1-27-flowered, up to 25 cm. in length, erect; peduncles 1.5-8 cm. long, pale greenish brown, slender, about 1 mm. in diam., sheathed with pale brown membranous sheaths at the base. *Flowers* 2.5-4 × 2.5-4.5 cm., pedicellate, pure white, to white deeply flushed with pink-lilac. *Bracts* 3 × 1.5 mm., broadly ovate, subacuminate, pale brown, scarious, 3-5-nerved. *Pedicel* with *ovary* 1.8 cm. long, pale yellowish, somewhat pink flushed. *Sepals* and *petals* white, or white flushed with pink-lilac, spreading, somewhat recurved, acute, entire; dorsal sepal 1.5-2.6 × 0.3-0.6 cm. oblong-lanceolate to ovate-lanceolate, 3-5-nerved; lateral ones 1.7-2.7 × 0.4-0.6 cm., oblong-lanceolate, 3-5-nerved, prolonged downwards at the base to form the mentum; mentum 0.8-1 × 0.5 cm., broadly conical, obtuse, pale yellow, straight or slightly incurved. *Petals* 1.6-2.7 × 0.6-1.3 cm., obovate-lanceolate to oblanceolate, acute, tapering to the base, entire, 3-nerved. *Lip* 1.9-3 cm. long, 3-lobed; lateral lobes 7-14 × 2.5-4 mm., more or less connivent upwards to enclose the column in a somewhat cylindrical, 9-15 mm. long tube-like structure, obliquely ovate-oblong, subacute, pale creamy yellow, rarely tinged with green to deep pink flushed with mauve, with red-brown veins on the inside; midlobe 1.3-2 × 0.8-1.7 cm., white, or white flushed with pink-lilac with several deeper-coloured veins, broadly ovate or ovate-oblong or subflabellate, acute, mucronulate or rounded-obtuse, entire. *Disc* on the lip creamy, grooved, obtuse or subemarginate, with yellow hairs at its base and apex. *Column* 3 × 2 mm., stout, short, lateral arms shortly toothed; clinandrium prolonged into a small outgrowth from the back wall; foot 6-8 × 3-4 mm., obovate, broadly hollowed with a small, 3-4 mm. long, pouch-like nectary. *Anther* 1.5 × 1.5 mm., ovate-oblong, pale yellow; pollinia 2 pairs, waxy, yellowish green, linear. *Stigmatic surface* broadly obovate-orbicular, creamy white. *Capsules* 2.2 × 1.2 cm., elliptic, pedicels 11 mm. long, somewhat curved, subclavate and with a broad beak 5 mm. long; capsule greenish purple with 3 broad and 3 narrow bands.

Leaves: June to October. *Flowering*: January to May. *Fruiting*: March to July.

Occurrence in Bombay State: DANGS: Ahwa, *Kapadia* 1596-1599. KHANDESH: *Hallberg*. KONKAN: *Stocks*; *Law*; Thana, *Bell*; *Kanitkar*; Kanheri Caves, *McCann*; Chiplun, *McCann*; Ratnagiri, *Kanitkar*. W. GHATS: Kasara, *McCann*; Igatpuri, *McCann*; Khandala, *Hallberg*; *Blatter*; *McCann*; *Santapau* 233.6, 233.29, 838, 1675-1676, 2223, 3613-3614, 4362, 4878, 6124, 8644-8645, 8768, 8788, 9179, 9965, 10787, 10951, 12261; *Herbert*; *Kapadia* 493, 511, 1063, 1091, 1093, 1176-1177, 1836-1842, 1942, 2317, Lonavla, *D. K. Patel*; *McCann*; *Kapadia*; Panchgani, *J. Fernandez*; *McCann*; Panchgani-Mahableshwar, *Blatter & Hallberg*; Mahableshwar, *Cooke*; *Ezekiel* 30321; *Acland* 1175; *Santapau* 12482; *Kapadia* 1919-1922, 2058-2059. DECCAN: Purandhar, *Santapau* 11457; Dapoli, *Acland* 1176; *Kanitkar*; Bhimashankar, *Kapadia* 1448; Radhanagar, Kolhapur, *Acland*, 1174; Koina nagar, Koina Valley, *Kapadia* 2878-2879. N. KANARA: Tinai Ghat, *Sedgwick*; Anmod, *Kapadia* 1876; Castle Rock, *Kapadia* 2773, 2794-2795, 2828-2829, 2878-2879, 2937.

Distribution: Dangs, Khandesh, Konkan, W. Ghats of Bombay State and S. India, Deccan, N. Kanara, Travancore.

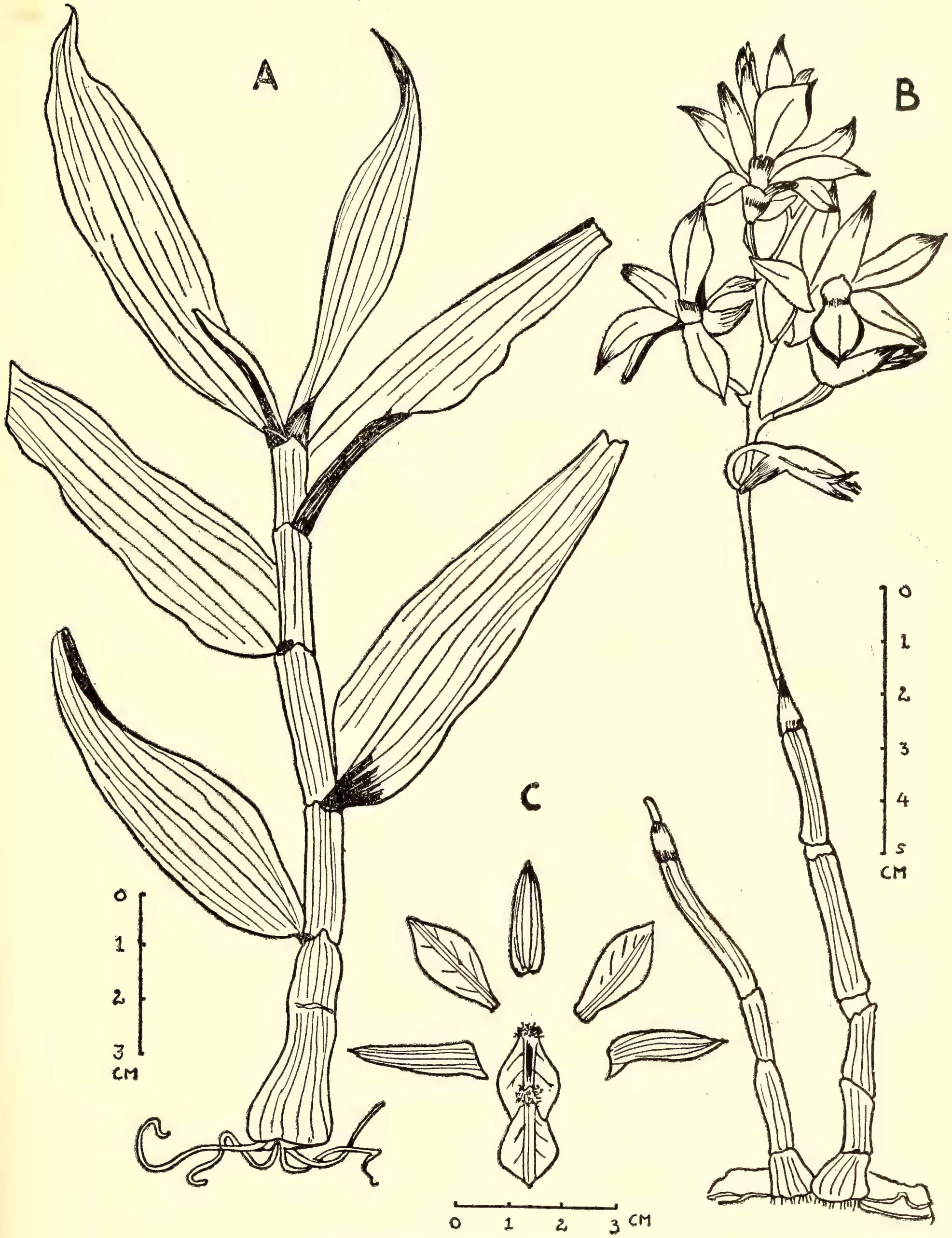
Notes: This species is epiphytic on a number of different trees and shrubs: *Terminalia* sp., *Syzygium* sp., *Heterophragma quadriloculare* Schum., *Carissa congesta* Wt., *Hymenodictyon* sp., *Sapium insigne* Benth., *Mangifera indica* L., *Salmalia malabarica* Sch. & Endl., *Vitex negundo* L., *Tectona grandis* L. f., *Ixora brachiata* Roxb., etc.

Some of the localities where this orchid is common and abundant are: Khandala, Mahableshwar and Koina nagar.

It may be of interest to point out that Rolfe (in *Gard. Chron.* 11 : 298, 1892) described *Dendrobium barbatulochlorops*, a natural hybrid between *D. barbatulum* Lindl. and *D. ovatum* Kränzl. (=*D. chlorops* Lindl.), which combines the characters of the 2 species. 'Briefly it may be described as *D. barbatulum*, a little modified in shape, with the crest and side lobes of the lip of *D. chlorops*. Good specimens from both the parent species from the same collection enable these characters to be easily traced.' (R. A. Rolfe, loc. cit.).

8. **Dendrobium macrostachyum** Lindl. Gen. Sp. Orch. 78, 1830, et in Bot. Reg. t. 1865, misc. 60, 1844; Wight, Icon. t. 1647, 1851; Hook. f. 735; Prain 1007; Gammie 17 : 32, 1906; Cooke 683; Kränzl. 59; Haines 1174; Fischer 1416; Blatt. & McC. 263. *Callista macrostachya* O. Kuntze, Rev. Gen. Pl. 2: 255, 1891. *Dendrobium gamblei* King & Pantling in Journ. As. Soc. Bengal II, 66 : 584, 1897; Duthie 99, t. 99 et Fl. Upp. Gang. Pl. 3 : 188, 1920; Kränzl. 59. (See Plate XXIII)

Pendulous *epiphytes*. *Pseudobulbs* leafless at the time of flowering, slender, 7-50 cm. long, more or less uniform, internodes 2-2.8 cm. long, 3-5 mm. thick, slightly swollen at the nodes, purplish brown with whitish longitudinal streaks. *Leaves* alternate, distichous, somewhat coriaceous, on drying becoming membranous, pale olive green, completely and closely sheathing the node below, 2-9 × 0.3-2.5 cm., narrowly lanceolate, oblong-lanceolate to ovate-lanceolate, acute, entire, usually with 3-5 fairly prominent nerves. *Inflorescence* solitary or in cymes; at first usually 3 buds are produced in basipetal succession, indicating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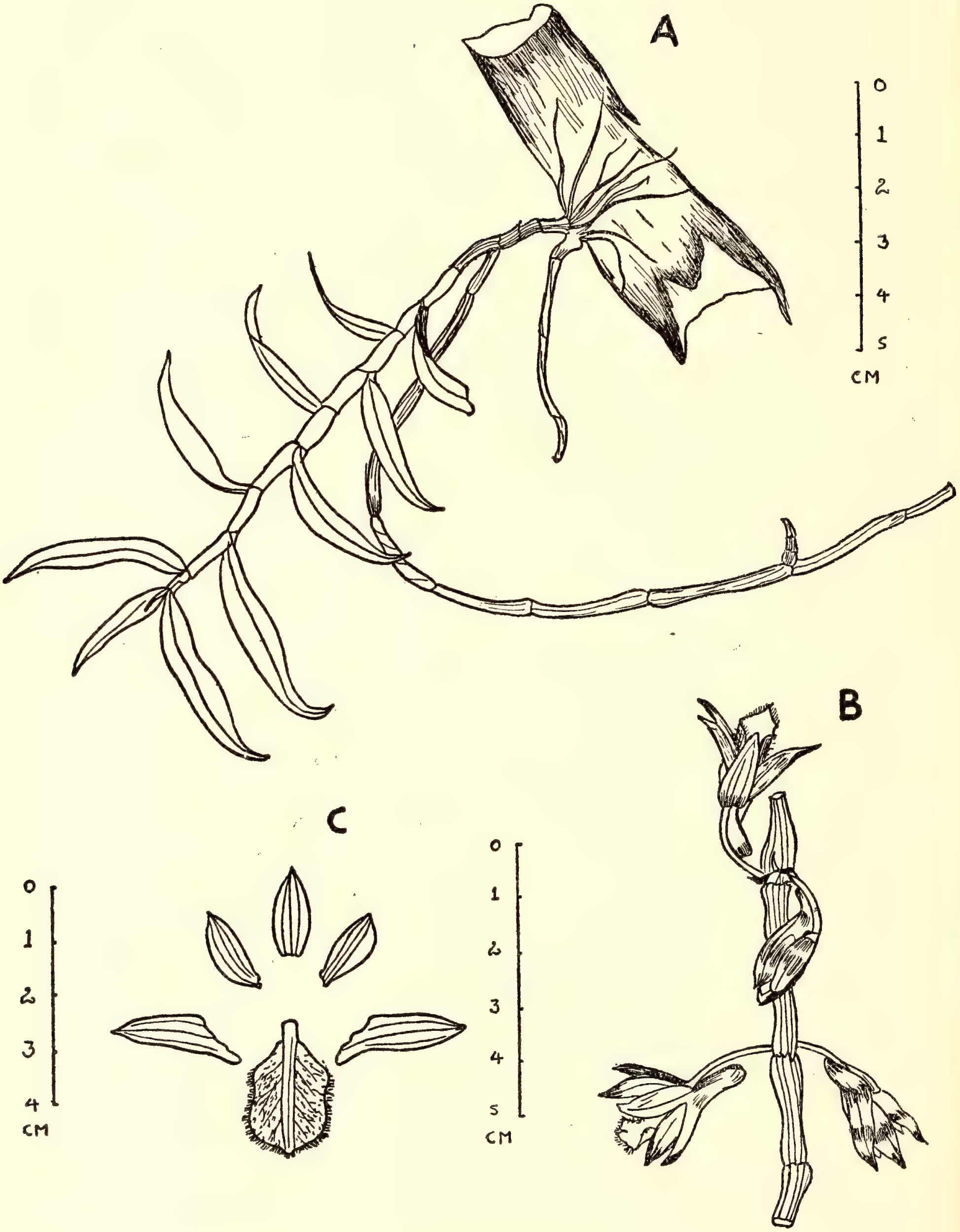
Dendrobium barbatulum Lindl.
A. Leafy plant ; B. Flowering plant ; C. Perianth segments.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Dendrobium macrostachyum Lindl.
A. Leafy plant; B. Flowering plant; C. Perianth segments.

a distinct dichasial cyme ; out of which generally 1 or 2, rarely all the 3, mature. *Peduncles* 2-3 mm. long, terete, thin, brown, sheathed. *Flowers* 2.5 × 2 cm., at first pale green, turning creamy yellow with age, faintly perfumed on opening, pedicellate. *Bracts* 2-3 × 1 mm., persistent, membranous, ovate, pale brown, 1-nerved. *Pedicel* with *ovary* 1.5-1.8 cm. long, curved, pale green above, tinged mauve below. *Sepals* and *petals* 1.5-1.7 × 0.6-0.8 cm., similar, not much spreading, creamy yellow, somewhat brittle, acute, entire, glabrous, faintly 5-nerved ; lateral sepals oblong-lanceolate, connivent below with the foot forming the mentum ; mentum 7 × 3-4 mm., infundibuliform, obtuse, straight or slightly curved. *Petals* obovate or oblanceolate, tapered to the base. *Lip* pale green or creamy yellow with brownish red slightly inflated nerves on the inside, obscurely 3-lobed with a 3-5 mm. long claw ; lateral lobes almost completely enveloping the column, obscure ; midlobe circular, half opening. The lip 25 × 15 mm., quadrately oblong or broadly subpanduriform in outline, only a shallow depression about the middle on the margin indicates the separation of the lateral lobes from the midlobe, obtuse ; margins minutely fimbriate, the apical half of the lip puberulous ; disc creamy yellow 3-nerved. *Column* 3 × 3 mm., greenish yellow, the lateral arms somewhat produced, acute ; foot 8 mm. long with a small nectarial depression at the base. *Anther* 2 × 2 mm., white, somewhat faintly pitted ; pollinia 4, each 1.5 × 0.5 mm. waxy, yellow, oblong. *Stigmatic surface* ovoid, pale green. *Capsules* 3.5-4 × 0.6 cm., narrowly spindle-shaped, beaked ; pedicels 1.5 cm. long.

Leaves : May to November. *Flowering* : May to June. *Fruiting* : May to December.

Occurrence in Bombay State : KONKAN : Southern parts, *Dalzell.* W. GHATS : Koina Valley, below Mahableshwar, *Cooke.* N. KANARA : Belgaum Ghats, *Gammie* ; Sampkhand, *Hallberg & McCann* 34192 ; Sirsi, *Blatt. Herb.* 34385 ; *Santapau* 18505, 18680 ; Sirsi-Siddhapur, *Kapadia* 2444 ; Siddhapur, *V. Patel* 1852 ; *Kapadia* 2375-2378 ; Jog, *Santapau* 18616 ; Bhagwati, *Kapadia* 1754-1760 ; Yellapur, *Sedgwick* ; *Bell* ; *Kapadia* 1771, 1969, 2000.

Distribution : *India* : Madhya Pradesh, Konkan, W. Ghats of Bombay State and S. India, Deccan, N. Kanara, Travancore. *World* : India, Ceylon.

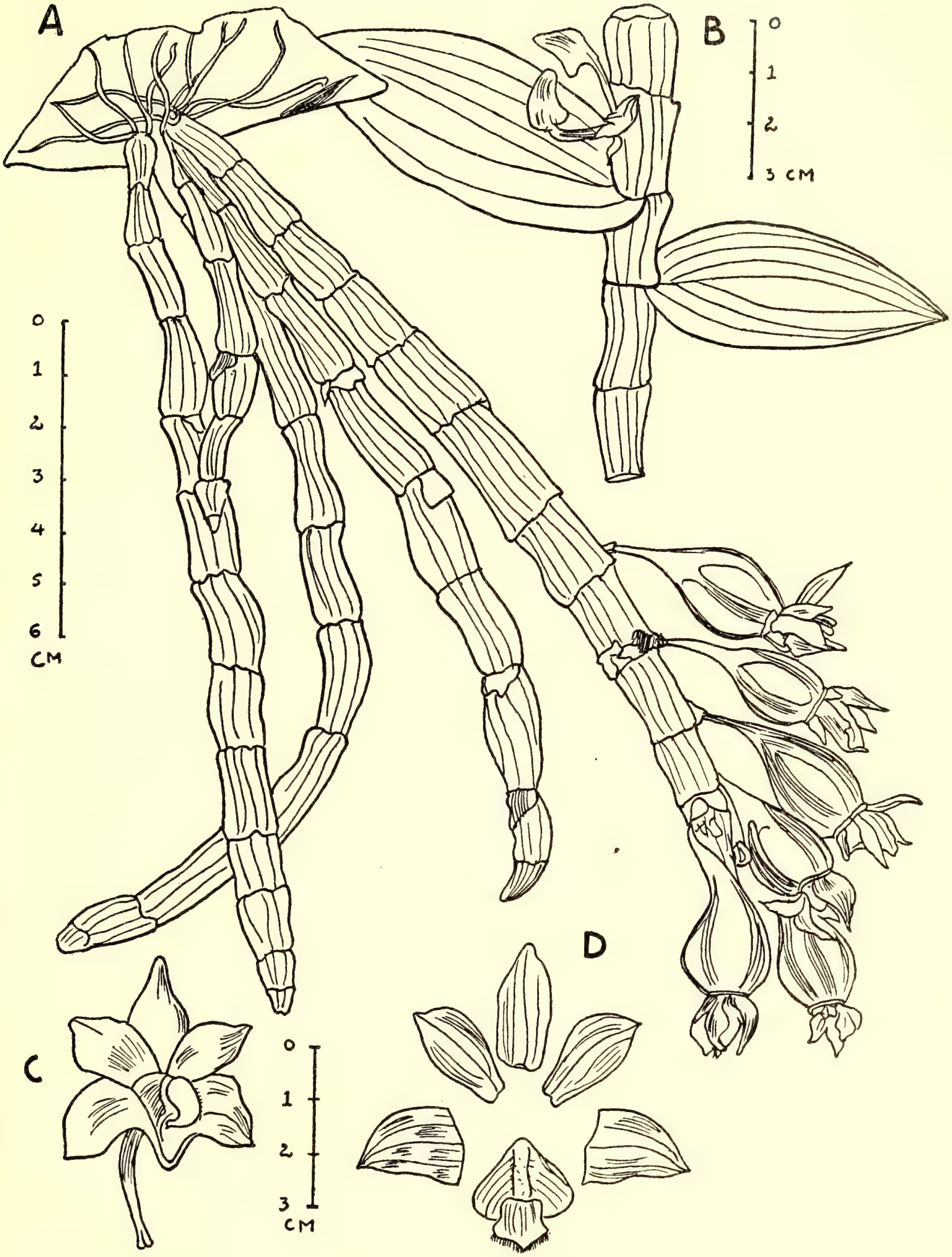
Notes : The differences between *D. gamblei* King & Pantl. and *D. macrostachyum* Lindl. seem to be slender. King & Pantling in their original description differentiate their *D. gamblei* from *D. macrostachyum* Lindl. in the following way : in the latter species " . . . the margins of the lip are slightly erose, not deeply fimbriate-serrate as in this ; the disc is naked in that, or has only a few scattered hairs ; the nectary and anther are entire in *D. macrostachyum*, and the flowers which are sweet-scented are in racemes". Duthie points out that *D. macrostachyum* differs from *D. gamblei* in the much-branched peduncles, the lip convolute at the base only and not ciliolate on the margins, and the leaves being membranous. Kränzlin distinguishes *D. gamblei* principally by the disc of the lip being villous and the margins fimbriate (not serrate).

Lindley describes *D. macrostachyum* "... floribus ternatis, racemum spurium formantibus, ... labello cucullato venoso ; limbo ovato obtuse ciliato intus pubescente". Prain describes the lip of *D. macrostachyum* Lindl. as fringed. Blatter & McCann remark from Bell's MSS notes : 'midlobe of lip embraces the whole column'. After a careful examination of abundant fresh material, we have found that the hairiness of the lip and the disc and also the degree of serration of the margin of the lip varies. Lindley himself mentions the lip of *D. macrostachyum* to be ciliate and pubescent.

From these considerations, we consider the differences between the 2 species not to be sufficient for keeping them apart. It may be pointed out that Fischer makes no mention of *D. gamblei* King & Pantl., in spite of the fact that the type locality for that species happens to be the Nilgiris. Wight's Icon no. 1647 does not seem to be very accurate.

9. **Dendrobium aqueum** Lindl. in Bot. Reg. misc. 6, t. 54, 1843 ; Hook. in Bot. Mag. t. 54, 1843 ; Hook. f. 739 ; Kränzl. 52 ; Fischer 1411 ; Blatt. & McC. 264. *D. album* Wight, Icon. 5 (1) : 6, t. 1645, 1851. *Callista aquea* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 654, 1891. (See Plate XXIV)

Pendulous, rarely erect *epiphytes*. *Pseudobulbs* 15-45 cm. long, thin at the base, gradually thickening upwards ; internodes 2-2.5 × 0.7-1.8 cm., the middle ones thickest, greyish brown, sheathed ; sheaths longitudinally striated, widening upwards. *Leaves* alternate, distichous, falling off just after flowering, 7-14 × 2-5 cm., sessile, oblong or oblong-elliptic or ovate-lanceolate, acute, entire, glabrous, 8-10-nerved. *Inflorescence* consists of fascicles of 2-3 flowers produced from the upper portion of each node along the distal half of the current season's pseudobulb. *Peduncles* hardly visible. *Bracts* 2-4, very small, membranous, imbricating at the base of the flowers, oblong or ovate-oblong, acute, entire, glabrous, translucent, 1-nerved. *Flowers* 3.5 × 2.8-3 cm., pedicellate, bracteate. *Pedicel* with *ovary* 2.7 cm. long, about 2 mm. in diameter, cylindrical, greenish white. *Sepals* white suffused with green, apiculate, entire, glabrous, 3-nerved ; lateral sepals 2 × 1.5 cm., ovate-triangular, subfalcate ; dorsal sepal 2.4 × 1.2 cm., broadly ovate. *Mentum* 11 × 6 mm., oblong, slightly funnel-shaped, obtuse. *Petals* 2.3 × 1.2 cm., spreading, white suffused with green, obovate-oblong or obovate, obtuse, slightly apiculate, entire, glabrous, 3-nerved. *Lip*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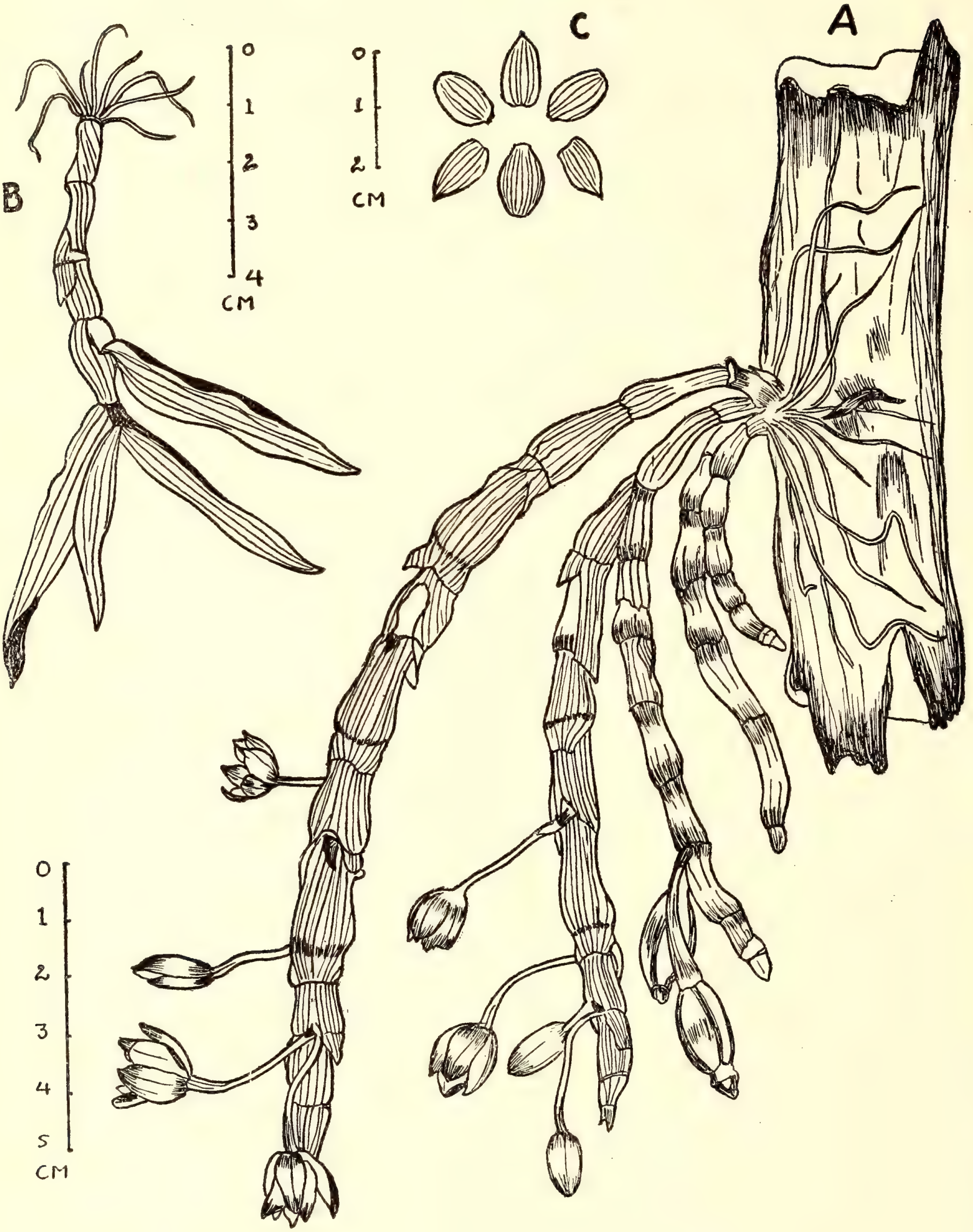
Dendrobium aqueum Lindl.
A. Fruiting plant ; B. Leafy shoot ; C. Single flower ; D. Perianth segments.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Dendrobium lawianum Lindl.
A. Flowering plant ; B. Leafy plant ; C. Perianth segments.

2.2 × 2 cm., 3-lobed, whitish green, pale yellow on the inside, subrhomboid, ascending from the base to the middle, then deflexed, triangular-round in front ; lateral lobes 6-7 mm. broad, obovate-oblong, rounded, entire, erect, connivent upwards, enclosing the column ; midlobe 10 × 10 mm., contracted inwards at the base, oblong-cuneate, acute, ciliolate ; *disc* 4 mm. broad, yellow, puberulous, extending up to the midlobe. *Column* 4-5 × 7 mm., stout, greenish white ; the arms projecting upwards and forwards, partially covering the anther in front ; foot 10 × 5 mm., stout, oblong, obtuse, curved, with a small, basal, pouch-like nectary. *Anther* greenish white, ovate-conical ; pollinia 4, yellow, oblong, subfalcate. *Stigmatic surface* truncate, oblong, small, pale green. *Ovary* 6 × 4.5 mm., pale greenish white, ribbed. *Capsules* 4 × 1.8-2 cm., obovate-pyriform, with 6 strong ridges 2.4 mm. deep, greyish green ; pedicels 1 cm. long, 2 mm. in diam., curved.

Leaves : June to October. *Flowering* : September to October. *Fruiting* : December to May.

Occurrence in Bombay : KONKAN : *Stocks* ex Kränzlin. W. GHATS : Mahableshwar, *Santapau* 12559 ; *Kapadia* 968, 1918, 1933-1935. DECCAN : Manched-Bhimashankar, *Kapadia* 1449.

Distribution : Konkan, W. Ghats of Bombay and S. India, Deccan.

Notes : The specific name *aqueum* refers to the pale watery green flowers.

Lindley mentions that the species is " a native of Bombay, whence it was imported by Messrs. Loddiges." Cooke and Blatter & McCann mention that the plant is often cultivated but has not been seen wild. We have found it to be fairly common at Mahableshwar.

10. **Dendrobium crepidatum** Lindl. in Paxton, Fl. Gard. 1 : 63, f. 45, 1850-1851, et nov. ed. 1 : 53, f. 40, 1882 ; Bot. Mag. tt. 4993, 5011 ; Hook. f. 740 ; Grant 78 ; King & Pantl. 48, t. 66 ; Prain 1007 ; Gammie 17 : 33, 1906 ; Cooke 683 ; Kränzl. 39 ; Haines 1175 ; Brühl 59 ; Blatt. & McC. 263, f. 7. *Callista crepidata* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 645, 1891.

Pendulous *epiphytes*. *Pseudobulbs* greenish yellow, 8-20 cm. long, narrow at the base, thickening upwards, about 0.6-2 cm. thick ; internodes about 2 cm. long, longitudinally striated, the nodes somewhat thickened. *Leaves* 4-11 × 0.5-1.5 cm., membranous, sheathing, oblong-lanceolate, acute, entire, glabrous, many-nerved. *Flowers* in pairs from the nodes of the apical parts of the pseudobulbs, pedicellate. *Bracts* minute, dry, scarious. *Pedicel* with *ovary* 23-28 mm. long, straight or slightly curved. *Sepals* about 15 × 6-7 mm., oblong, obtuse or mucronulate, fleshy, entire, 5-nerved ; mentum 2-4 mm. long, shortly quadrate-rounded. *Petals* 15 × 7 mm., broadly oblong, spreading, wavy, abruptly tapered at the very base, obtuse, 5-nerved. *Lip* 17 × 11-13 mm., hardly lobed, oblong-orbicular in outline, with a narrow, 3-4 mm. long claw ; basal portion erect, more or less connivent round the column, forming a hollow at the base ; apical half spreading, wavy or slightly crimped, puberulous, rounded or shallowly emarginate at the apex. *Column* 3-4 mm. long, oblong with curved foot about 4 mm. long. *Anther* conical-oblong. *Flowers* are said to be white tipped with pink, the base of lip deep yellow.

Occurrence in Bombay State : KONKAN : *Law, Stocks* ; Vengurla, *Dalzell.* W. GHATS : Lonavla, *Gammie* ; Mahableshwar hills, *Cooke.* DECCAN : Koina nagar, Koina Valley, *Kapadia* 2872-2874.

Distribution : *India* : Sikkim, Assam, Khasia Hills, Bihar and Orissa, Deccan. Kränzlin mentions Malabar, but Fischer does not include the species in the FLORA OF THE PRESIDENCY OF MADRAS. *World* : India, Burma.

Notes : We have not been able to collect flowering specimens of this species. The details of the flowers have been studied from specimens in the Herbarium of the Botanical Survey of India (Western Circle) with the kind permission of the Regional Botanist.

Haines has taken his description from Pantling. Plants from Chota Nagpur differ in the flowers being 3.2 cm. in diam. and pink with buff at the base of the lip. This seems to be *D. lawianum* Lindl. and not *D. crepidatum* Lindl.

11. **Dendrobium lawianum** Lindl. in Journ. Linn. Soc. 3 : 10, 1859 (*lawanum*) ; Dalz. & Gibs. 261 ; Kränzl. 297. *Dendrochilum roseum* Dalz. in Hook. Kew Journ. 4 : 291, 1852. *Dendrobium crepidatum* Lindl. var. *avita* Gammie in Journ. Bombay nat. Hist. Soc. 17 : 33, 1906. *Callista lawiana* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 655, 1891. (See Plate XXV)

Pendulous *epiphytes. Pseudobulbs* 5-25 cm. long, leafless at the time of flowering, usually all curving in one direction, rarely straight, tapering at both ends ; internodes 2 cm. long, 1.2 cm. thick at the nodes, clavate, green ; generally completely enclosed in a scarious, many-nerved sheath which arises at a node and extends to about the middle of the next internode ; tip of the sheath about 1 cm. broad, broadly emarginate ; rarely the pseudobulbs are completely without sheaths, yellowish green. *Leaves* 4.5-10.5×0.5-1.7 cm., distichous, sessile, sheathing at the base, lanceolate or oblong-lanceolate, acute, entire, with usually 5 prominent nerves and several faint ones. *Flowers* subregular, shallowly cup-shaped, from the nodes in pairs or solitary ; mentum absent. *Pedicel* with *ovary* 2.5-3.5 cm. long, white flushed with pink-purple near the flower, terete. *Bracts* minute, 2-5 mm. long, pale brownish, scarious. *Sepals* and *petals* waxy, white flushed with rose-purple towards the apex. *Sepals* 12-15 × 6-8 mm., broadly oblong, subobtuse, mucronate, the margins meeting a little above the apex, entire, faintly 5-nerved. *Petals* 12-15 × 6.5-10 mm., broadly ovate-oblong, entire, obtuse or slightly retuse, faintly 5-nerved. *Lip* 12-17 × 8-10 mm., broadly ovate-oblong, broader than the petals, obtuse or retuse, slightly clawed at the base, waxy, similar in coloration to the sepals and petals, the rose-purple flush somewhat deeper. *Column* 2.25 × 2.5 mm., stout, white with 2 purple or white processes at the base, behind which there is a deep cavity (probably a nectary) ; the sides with 2 minute purple or white horns ; clinandrium broad-quadrate, the back margin with a central, 1 mm. long, apiculum to which the anther is attached. *Stigmatic surface* quadrate just below the clinandrium, glutinous, generally self-pollinated. *Anther* 3 × 2.5 mm., oblong, suborbicular, flat on top with a central transverse band, 2-celled, white flushed with rose-purple ; *pollinia* 2 pairs, 1.5 mm. long, waxy, golden-yellow, without caudicle or glandular-viscid appendage. *Capsules* 2 × 1 cm., ovoid, pale-green, ribbed, surmounted by the hardened pale brown column, pedicellate ; pedicels 2.5-3 cm. long, clavate, green.

Leaves : May to October. *Flowering* : March. *Fruiting* : April onwards.

Occurrence in Bombay State : KONKAN : *Law* ; Bombay, cultivated, *Kapadia* 1389. W. GHATS : Sahyadree Hills *Dalzell.* N. KANARA : Yellapur, *Kapadia* 1988 ; Kumbelli Mines, about 17 miles from Supa, *Kapadia* 2579-2580, 2725-2726 ; Castle Rock, *McCann* 13768 ; *Kapadia* 2834, 2843-2850 ; Anmod, *Sedgwick* 3319 ; *Kapadia* 1868, 1892-1895 ; Siddhapur, *V. Patel* 1851 ; *Kapadia* 2370-2371 ; Jog, *Santapau* 18603 ; *Kapadia* 1846 (coll. *Pirson*).

Distribution : Chota Nagpur (?), Konkan, W. Ghats, N. Kanara.

Notes : We have collected abundant fresh material from the type locality (Castle Rock) of *D. actinomorphum* Blatt. & Hallb. and from other places in N. Kanara. The type specimen of *D. actinomorphum* (*McCann* 13768) is preserved in formalin in St. Xavier's College, and has been available for study. We have come to the conclusion that *D. actinomorphum* Blatt. & Hallb. and *D. lawianum* Lindl. are identical and that this species is quite distinct from *D. crepidatum* Lindl. though externally somewhat similar. It has been included under the latter species by most authors. Kränzlin has included *D. lawianum* Lindl. as a synonym of *D. crepidatum* Lindl. on page 39 ; but then, he also describes *D. lawianum* Lindl. as a distinct species under the heading '*Dendrobia adhuc solummodo in statu pelorioideo nota*' on page 297.

This species is quite common all over N. Kanara and may have been easily mistaken for *D. crepidatum* Lindl., from which it can be easily distinguished by the lip, which is similar to the sepals and petals with no trace of pubescence and by the yellow coloration at the base of the lip ; the column is also characteristic in shape and is without a foot. *D. lawianum* Lindl. does not seem to be a mere accidental variation, for it is found to be distributed all over N. Kanara, and may probably occur in Chota Nagpur. The characteristic structure of the column at once distinguishes it from all other *Dendrobia* ; but absence of foot and mentum, with the almost regular flowers throws considerable doubt as to the correctness of including it in *Dendrobium.* Its general habit, however, is that of a normal *Dendrobium* and we think it best to retain it in the genus, though in an independent section.

The earlier specific epithet *roseum* of Dalzell cannot be used for this species on account of *D. roseum* Sw. (1805).

Analysis of the Proteins of Egg-white as an aid to the Classification of Birds

BY

D. B. PEAKALL, M.SC., PH.D., M.B.O.U.

(*With one text-figure*)

Proteins are complex organic compounds and are present in all living things. Their importance is indicated by the fact that both enzymes and genes are proteins. Proteins are also found in muscle, feathers, internal organs, etc., and form the principal components of blood. There are a vast number of different proteins and every species has a different protein structure. The differences and similarities are exploited in the use of protein analysis for classification.

In order to see the use of protein analysis as an aid to classification in perspective it is perhaps worthwhile to consider briefly the ideas and difficulties of classification. Classification is an attempt to map out evolutionary history. Unfortunately the fossil record of avian history is very poor. The major evolution of birds occurred in the Cretaceous period, and virtually no avian fossils have been found belonging to this period. There are the early fossil birds, the Archaeopteryx, which show that different parts evolve at different rates since the feathers were avian but the rest largely reptilian (de Beer, 1954). But, in general, fossil records have been of little aid in classification.

The Darwinian concept was that evolution proceeded from the lower to the higher, that is to say from the simpler to the more complex. It is now considered that this rule is not invariable, in any case it is difficult to know what is primitive and what is advanced. Many, one might almost say all, taxonomic characters have been used. It is difficult to know which characters are of major importance, that is, have generic value, and which are easily modified by external conditions. This is one of the great difficulties of classification, to distinguish between those characters which are similar because of recent descent from a common ancestor and those which are similar because of changes caused by adaptation to a common environment, even though they have had a quite distinct evolutionary history. For a fuller account of these problems the reader is referred to a recent review by Mayr (1959).

Besides what we may call classical methods, several others have been suggested. All have some value, and all their limitations. The study of parasites has been suggested (Clay, 1951). Parasites evolve together with their hosts and, being simpler animals, may have changed less. However, transfer is possible (Mayr, 1957) and the method must be used with caution.

Behaviour is being used to an increasing extent in the study of evolution (Lorenz, 1958; Cullen, 1959; Tinbergen, 1959). It seems that behaviour characters are as conservative as taxonomic charcters, although care must be taken to distinguish between true differences in behaviour and those caused by the local environment.

The relationship of protein analysis to classification has been known for some time. Nuttall (1901) used the analysis of blood serum to examine the zoological classification of many animals. These early investigations, although interesting, were too crude to give any significant results. There have been more recent investigations, but serology has not been widely used in avian systematics. Immunological studies show that each species has its specific antigens[1]. The studies of Irwin and co-workers [for example Irwin (1953)] have given information on the classification of the doves (Columbidae).

The most convenient source of proteins is egg-white, which consists mainly of water and proteins. The specific nature of the proteins in egg-white was first shown by immunological studies (Landsteiner & van der Scheer, 1940), but the use of electrophoresis has given a more convenient and reliable method. This method was first used in classification studies by McCabe & Deutsch (1952) and since then Sibley, using a much improved apparatus, has obtained greater accuracy and has examined the electrophoretic pattern of a large number of species. Sibley (1960) gives a full account of this work and considers in detail the validity of this method and the results obtained to date.

The formidable-looking word electrophoresis (from Gr. *phoros* to bear, *electro* by electricity) is to bear or carry something by electricity. In more scientific terms it is the transportation of charged bodies in an electrical field. Thus, if proteins are placed in an electrical field they will migrate because they have an electrical charge. Because of the different size of the molecules and the differing electrical charge, different proteins move at different speeds and thus a separation is achieved. The usual method is to place a few drops of protein on a strip of wet filter paper, across which an electrical field is placed. This field is of high voltage but of low current. After the proteins have been under the influence of this field for some hours, the strip of paper is dried and then dyed. This dye reacts with the protein to give a coloured compound which enables the position of the colourless proteins to be seen. The amount of protein present in the various bands can be determined by the optical density, the blackness, of the paper strip. Machines are available that translate the optical density of paper into a curve of optical density plotted against the distance that the protein has been moved by the electrical field.

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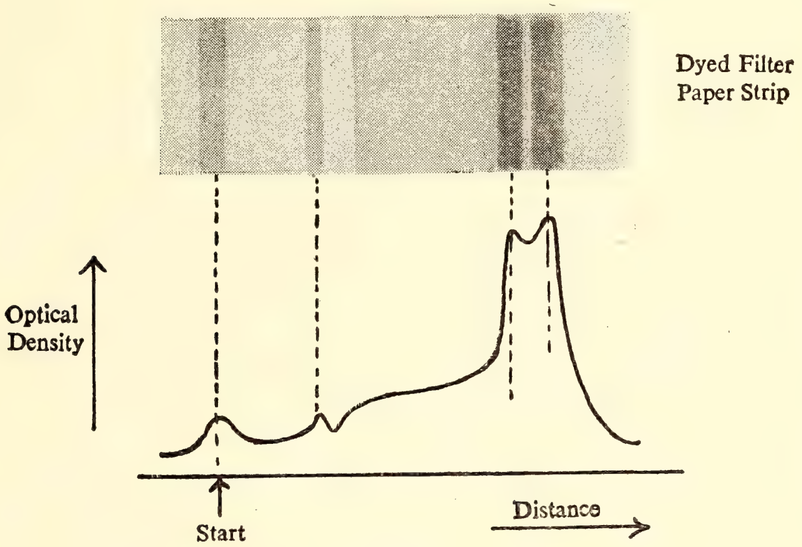
[1] Substances which stimulate the formation of antibodies.—Eds.

The figure below shows a drawing of a dyed filter paper strip and the optical density curve obtained from it. The curve shown above was obtained by Spofford and is of a Redtailed Buzzard (*Buteo jamaicensis*) which is found in North America and is similar to the Desert Buzzard (*B. desertorum*). It is in the classification of the hawks that we are especially interested. We should be most grateful for any egg-white specimens of this family.



The use of protein analysis in determining the classification of birds can best be shown by a few examples.

One interesting problem in classification is posed by the flamingos (Phoenicopteridae). Are these spectacular birds related to the ducks (Anatidae) as their webbed feet, bill structure, and swimming habits suggest but have evolved long legs, or are they more closely related to the storks (Ciconiidae) but have evolved some duck-like characters because of their environment? The analysis of egg-white protein supports the view that the flamingos are more closely related to the storks than to the ducks.

Another case that illustrates the fact that protein structure changes only slowly is in the Brown Hawk of Australia. Apparently, because there are no true buzzards in Australia, this species has altered its feeding habits from those of a typical falcon and now resembles those of the slow-moving buzzard. The species has been considered by some to belong to the true falcons and has been called *Falco berigora*, whilst others have placed it in a separate genus and named it *Ieracidae berigora*. When I first saw this species, in Tasmania, I thought that it was a buzzard both by stance and hunting, although the wings were more pointed than in the buzzards. The analysis of the egg-white proteins indicates that the Brown Hawk is very closely related to the five other species of the *Falco* that have been examined. Thus the separate genus for this species is probably not justified. This example shows that the protein composition changes only slowly; here more slowly than some external features. This conservative nature of proteins increases their value in systematics.

Many other problems remain. Is the strange Secretary Bird (*Sagittarius serpentarius*) that stalks the plains of Africa really a hawk? Does the Osprey (*Pandion haliaetus*) really deserve a separate family? If not, what is it closely related to? There are many other problems. One of the great difficulties of this work is obtaining samples from all parts of the world. It is essential to examine this problem on a world-wide basis. We should therefore be grateful for samples of egg-white, not only of hawks but of any species.

INSTRUCTIONS FOR THE COLLECTION OF EGG-WHITE

If the egg-shell is not required for oological purposes, a large piece of the shell is removed and the egg-white can be tipped into a small container. It is important that the egg-white is not contaminated with yolk. If the egg shell is required for an oological collection the shell is drilled as usual. While blowing the egg the contents are collected in small portions and those contaminated with yolk are thrown away, the rest put into the collecting vessel.

Egg-white has only a limited life at normal temperatures and it is necessary either to keep the samples refrigerated or to send them off within a few days. It is requested that the samples are sent air-mail; postage will be refunded.

It is possible to make a satisfactory analysis on a small sample, i.e. the contents of one small egg. However if the species is abundant, it is useful to have the contents of several eggs, as a more detailed analysis can then be made.

The egg-white can be sent in any clean, convenient vessel, but anyone who thinks that he may be able to help is asked to write to Dr. Walter Spofford, Upstate Medical Center, 766 Irving Avenue, Syracuse, 10, New York, U.S.A., and a collecting kit will be sent.[1]

It is important that the eggs are identified with certainty, and that every sample is clearly labelled.

SUMMARY

Protein analysis is considered to be a useful addition to the characters used in determining the classification of birds. The method of analysis is briefly described and some account is given of the results already obtained. It is hoped that members of the Society will aid this work by sending in specimens of egg-white protein. Details of how this should be done are given at the end of the article.

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[1] Some kit has already been received by the Bombay Natural History Society and the Honorary Secretary will be glad to distribute it among those interested.—EDS.

The Birds of Nepal

PART 2

BY

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Zoological Survey of India, Indian Museum, Calcutta

[*Continued from Vol.* **57** (2):308]

Order GRUIFORMES

Family GRUIDAE

*133. **Grus grus lilfordi** Sharpe. Common Crane.

The Common Crane was not found by us in Nepal. Hodgson's earlier collection did not contain any specimen (Gray & Gray, 1846), but his later collection presented to the British Museum after he left Nepal had this species included (Gray, 1863, p. 71). Sharpe (1894, p. 254) listed four Hodgson specimens from Nepal. Scully (1879, p. 352) observed it in the central tarai and dun in winter, and noted that it passed over the Nepal Valley on migration without alighting there. Ripley (1950b, p. 368) saw it in the western lowlands in winter. Rand & Fleming (1957, p. 64) made a doubtful sight record.

*134. **Grus antigone antigone** (Linnaeus). Sarus Crane.

We did not find the Sarus Crane in Nepal. It was not included in Hodgson's first lot of specimens (Gray & Gray, 1846), but was mentioned in his later collection (Gray, 1863, p. 71). Sharpe (1894, p. 264) listed a single Hodgson skin. Scully (1879, p. 352) found it common in the central tarai. Ripley (1950b, p. 368) and Rand & Fleming (1957, p. 64) met with it in the western lowlands in winter.

*135. **Anthropoïdes virgo** (Linnaeus). Demoiselle Crane.

We were unable to find the Demoiselle Crane in Nepal. Scully (1879, p. 352) observed that it was common in the central tarai and dun in winter, and that it passed over the Valley on migration, occasionally alighting there for a short while. Ripley (1950b, p. 368) found it as a visitor in the Valley in mid-winter and early spring. Rand & Fleming (1957, p. 64) made a doubtful sight record.

Family OTIDIDAE

*136. **Ardeotis nigriceps** (Vigors). Great Indian Bustard.

The Great Indian Bustard has been recorded from Nepal only through Hodgson's specimen (Gray & Gray, 1846, p. 130), which was not, however, included in Sharpe's (1894, pp. 327-328) list.

*137. **Eupodotis bengalensis bengalensis** (Gmelin). Bengal Florican.

*138. **Eupodotis indica** (J. F. Miller). Likh or Lesser Florican.

Both the floricans are known from Nepal only through Hodgson's specimens (Gray & Gray, 1846, p. 130).

Family RALLIDAE

*139. **Rallus eurizonoïdes amauroptera** (Jerdon). Banded Crake.

Hodgson's collection (Gray & Gray, 1846, p. 143) appears to provide the only record of the occurrence of the Banded Crake in Nepal.

*140. **Porzana pusilla pusilla** (Pallas). Baillon's Crake.

The last record of Baillon's Crake from Nepal seems to be Scully's (1879, pp. 358-359) who found it in the Valley from July to December.

*141. **Porzana fusca bakeri** Hartert. Ruddy Crake.

There does not appear to be any post-Hodgsonian record of the Ruddy Crake from Nepal.

*142. **Porzana bicolor** Walden. Elwes's Crake.

Sharpe (1894, p. 114) listed one of Hodgson's specimens under this species, and that forms its sole record from Nepal.

143. **Amaurornis akool akool** (Sykes). Brown Crake.

DUN : Hitaura : 1 ♂ (June 7).

The single specimen of the Brown Crake was obtained from a small stream in a dense patch of forest at Hitaura.

It was not included in the earlier catalogue of Hodgson's collection (Gray & Gray, 1846), but the later one (Gray, 1863, p. 75) mentioned it from Nepal (one specimen, see also Sharpe, 1894, p. 156). Neither Scully (1879), nor Ripley (1950b) reported it thence, though Rand & Fleming (1957, p. 64) occasionally found it in the duns and lowlands.

My specimen is in worn plumage.

Measurements : 1 ♂ : Wing 125+; tail 56+; bill 33.

144. **Amaurornis phoenicurus chinensis** (Boddaert). Chinese White-breasted Waterhen.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 9, May 12). DUN : Hitaura ; 3 ♂♂, 1♀ (May 12-30, June 23).

The Whitebreasted Waterhen is not an uncommon bird in the central bhabar and dun on rivers, particularly in dense reed-beds.

Neither Scully (1879) nor Ripley (1950b) recorded it from Nepal.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	167, 169, 171, 177	72, 74, 75 (2)	40, 42, 42.5, —
2 ♀♀ :	154, 157	66, 67	35, 36

The bill in this species has been measured from the posterior edge of the shield to the tip of the bill.

*145. **Gallinula chloropus indica** Blyth. Indian Moorhen.

We did not come across the Indian Moorhen, nor did Scully (1879), or Ripley (1950b). Rand & Fleming (1957, p. 64), however, found it common in the swamps of the lowlands.

*146. **Porphyrio porphyrio poliocephalus** (Latham). Purple Moorhen.

The Purple Moorhen has not been reported from Nepal after Hodgson's collection.

*147. **Fulica atra atra** Linnaeus. Coot.

Neither Ripley (1950b) nor we came across the Coot in Nepal. However, Scully (1879, p. 358) found it as a winter visitor to the Nepal Valley in small numbers ; Proud (1949, p. 718) saw it only once (a pair) in the Valley in January ; and Rand & Fleming (1957, pp. 64-65) had specimens brought for them from *c.* 915 m. and *c.* 2745 m. in west-central Nepal in November.

Family TURNICIDAE

*148. **Turnix sylvatica dussumier** (Temminck). Little Bustard-Quail.

Hodgson's collection (Gray & Gray, 1846, p. 129) furnishes the only record of the Little Bustard-Quail from Nepal.

149. **Turnix tanki tanki** Blyth. Indian Button Quail.

Turnix tanki Blyth, 1843, *J. Asiat. Soc. Beng.* **12**:180. (No locality=Bengal, based on drawing by Buchanan-Hamilton, hereby restricted to northern suburbs of Calcutta.)

DUN : Hitaura : 3 ♀♀ (May 14, 24, July 1).

The Indian Button Quail is rather scarce in central Nepal, having been met with by us only on a few occasions in scrub and in cultivated fields in the dun.

Scully (1879), Ripley (1950b), and Rand & Fleming (1957) do not include it in their lists.

Measurements : 3 ♀♀ : Wing 85, 88 (2) ; tail 33, — (2) ; bill 14, 15 (2).

150. **Turnix suscitator plumbipes** (Hodgson). Himalayan Bustard-Quail.

BHABAR : Amlekhganj : 1 ♂ (March 9). DUN : Bhimphedi : 1 ♂ (May 10).

The Himalayan Bustard-Quail does not appear to be common in Nepal. Although Scully (1879, p. 350) recorded a single example from the Nepal Valley, subsequent workers failed to find it there. Ripley (1950b, p. 368) reported it only from the eastern tarai in winter, and Rand & Fleming (1957, p. 63) from *c.* 1065 m. in western Nepal in the same season.

Measurements : 2 ♂♂ : Wing 86, 92 ; tail 30+, 34 ; bill 14, 14.5.

Order CHARADRIIFORMES

Family JACANIDAE

*151. **Hydrophasianus chirurgus** (Scopoli). Pheasant-tailed Jaçana.

Hodgson's collection provides the only record of the Pheasant-tailed Jaçana from Nepal.

*152. **Metopidius indicus** (Latham). Bronzewinged Jaçana.

Rand & Fleming's (1957, p. 65) is the only post-Hodgsonian record of this jaçana from Nepal. They found it common throughout the tarai.

Family BURHINIDAE

153. **Burhinus oedicnemus indicus** (Salvadori). Indian Stone Plover.

BHABAR : Amlekhganj : 1 ♂ (March 9). DUN : Hitaura : 1 ♂ (May 24).

We found the Stone Plover on a few occasions on the sandy or shingle beds of the larger rivers in the bhabar and dun of central Nepal.

Scully (1879) did not record it from Nepal. Ripley (1950b, p. 369) found it in the western tarai in winter. Rand & Fleming (1957, p. 68) reported it from the central dun in April. Proud (1955, p. 72), on the other hand, came across it in the Nepal Valley once on August 28.

Measurements : 2 ♂♂ : Wing 214, 217 ; tail 110+, 112+ ; bill 42, 43.

*154. **Burhinus recurvirostris** (Cuvier). Great Stone Plover.

There has been no report of the occurrence of this stone plover in Nepal after Hodgson's (Gray & Gray, 1846, p. 131).

Family HAEMATOPODIDAE

*155. **Haematopus ostralegus osculans** Swinhoe. Eastern Oystercatcher.

The occurrence of the Oystercatcher in Nepal is known only from Hodgson's collection (Gray & Gray, 1846, p. 133).

Family CHARADRIIDAE

Subfamily CHARADRIINAE

I agree with Bock (1958, pp. 57-59) in synonymizing *Hoplopterus* Bonaparte, *Lobivanellus* G. R. Gray, *Chettusia* Bonaparte, *Lobipluvia* Bonaparte, and *Microsarcops* Sharpe with the genus *Vanellus* Brisson.

*156. **Vanellus leucurus** (Lichtenstein). Whitetailed Lapwing.

The first and only record of the occurrence of the Whitetailed Lapwing in Nepal is to be credited to Rand & Fleming (1957, p. 65) who found it on two occasions in the lowlands of western Nepal in winter.

*157. **Vanellus vanellus** (Linnaeus). Lapwing or Peewit.

Hodgson's collection provides the sole record of the occurrence of the peewit in Nepal.

158. **Vanellus indicus indicus** (Boddaert). Indian Redwattled Lapwing.

TARAI : Simra : 1 ♂ (March 6). BHABAR : Amlekhganj : 1 ♂ (March 9). DUN : Hitaura : 1 ♂, 1 juv. ♂, 2 ♀♀, 1 juv. ♀ (June 4, 23, July 15).

The Redwattled Lapwing is common on the streams, paddy fields, etc. of the central tarai, bhabar, and dun. It also occurs in small numbers in the Nepal Valley where it has been reported to be resident (Scully, 1879, p. 352 ; Proud, 1949, p. 718). Ripley (1950b, p. 368) recorded it from the tarai in winter, and Rand & Fleming (1957, p. 65) found it up to *c.* 1065 m. in winter.

The adult specimens taken in June and July are worn.

The juvenile female specimen (June 4) is very young. It has the crown with rufous edged feathers, mantle and scapulars barred with pale rufous brown, and the chin and throat white. The juvenile male (June 23) is a little larger. It is similar in coloration to the juvenile female, but has the crown dark brown.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	218, 232, 234	110, 116+, 119	37.5, 39, 40
2 ♀♀ :	221, 224	107+, 112+	38 (2)

159. **Vanellus duvaucelii** (Lesson). Indian Spurwinged Plover.

BHABAR : Amlekhganj : 2 ♂♂ (March 6, 9). DUN : Hitaura : 1 ♂, 2 ♀♀ (May 25, 26, June 19).

The Spurwinged Plover is quite a common bird in Nepal, occurring on the rivers of the bhabar and dun, especially on their shingle beds. We did not find it in the Nepal Valley, although Scully (1879, p. 352) recorded it as fairly common there during summer. Rand & Fleming (1957, pp. 65-66) noted it as common in western and west-central Nepal from the tarai up to *c.* 915 m. in winter. Biswas (1960a) found it on the banks of Arun River, eastern Nepal, at *c.* 670 m. in June. Ripley (1950b) failed to come across it in Nepal.

My June specimen is worn.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	194, 196, 204	89, 92, 97	35, 36 (2)
2 ♀♀ :	193, 202	88, 90	33.5, —

Some authors, such as Ripley (in press)[1] prefer to treat *duvaucelii* as a subspecies of *V. spinosus*, with which I do not agree.

*160. **Vanellus malabaricus** (Boddaert). Yellow-wattled Lapwing.

The only post-Hodgsonian record of the Yellow-wattled Lapwing from Nepal is due to Proud (1949, p. 718) who occasionally found it in the Valley during monsoon.

*161. **Pluvialis squatarola** (Linnaeus). Grey Plover.

The occurrence of the Grey Plover in Nepal is based only on Hodgson's collection (Gray & Gray, 1846, p. 131).

*162. **Pluvialis dominica fulva** (Gmelin). Eastern Golden Plover.

The last record of the Golden Plover in Nepal was Scully's (1879, p. 351) who found it in the Valley on passage in September-October.

*163. **Charadrius leschenaultii leschenaultii** Lesson. Large Sand Plover.

Hodgson's collection (Gray & Gray, 1846, p. 132) furnishes the sole record of the Large Sand Plover from Nepal.

164. **Charadrius dubius jerdoni** (Legge). Jerdon's Little Ringed Plover.

NEPAL VALLEY : Thankot, Kathmandu : 2 ♂♂, 2 ♀♀ (April 12, 25).

We found the Little Ringed Plover not uncommonly in the Nepal Valley from about the beginning of April. It occurred on rivers and streams in pairs or in loose parties. Ripley (1950b) did not record it from Nepal.

A male and a female taken on April 25 had somewhat enlarged gonads. The testes measured 5×4 (right) and 7×4 (left), and the ovary, 6×6, the largest ovum being 3.25 mm. in diameter.

Colours of soft parts : Iris dark brown; eyelids bright yellow; bill black with the base of the upper mandible and the basal third of the lower mandible yellow; legs and feet dull greyish olive; claws black; pads fleshy.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	107, 109	55, 58	16, 17
2 ♀♀ :	105, 111	54, 60	16, 17

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[1] References to Ripley (in press) in parts 1 and 2 of this series and in the parts to follow are based on the galley proofs of A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, which the author had the privilege of seeing. The text as finally published may, of course, differ from the galley proofs.

*165. **Charadrius alexandrinus alexandrinus** Linnaeus. Kentish Plover.

Although not mentioned in either edition of catalogues of Hodgson's collections (Gray & Gray, 1846 ; Gray, 1863), three specimens of the Kentish Plover from Nepal presented by Hodgson were listed by Sharpe (1896, p. 281). Later, only Rand & Fleming (1957, p. 66) have reported it from Nepal (eastern tarai) in winter.

*166. **Charadrius placidus** J. E. & G. R. Gray. Longbilled Ringed Plover.

The last record of this plover from Nepal was by Scully (1879, p. 351) who found it as an uncommon bird in Nawakot district, central Nepal, in November.

*167. **Charadrius mongolus atrifrons** Wagler. Lesser Sand Plover.

The only Nepali record of this Sand Plover is in Hodgson's collection (Gray & Gray, 1846, p. 133).

Subfamily SCOLOPACINAE

*168. **Numenius phaeopus ? variegatus** (Scopoli). Eastern Whimbrel.

The Whimbrel has not been reported from Nepal after Hodgson's collection.

*169. **Numenius arquata orientalis** C. L. Brehm. Eastern Curlew.

The post-Hodgsonian records of the Curlew in Nepal are Scully's (1879, p. 356) who found it as a rare visitor to the Valley where Proud (1949, p. 718) observed it only once (August) ; and Biswas's (1960a) who reported hearing it on the Khumbu glacier, eastern Nepal, at *c.* 5790 m. in May.

*170. **Limosa limosa limosa** (Linnaeus). Blacktailed Godwit.

Scully's (1879, p. 356) is the only record of the Blacktailed Godwit from Nepal since Hodgson's days.

*171. **Tringa erythropus** (Pallas). Spotted or Dusky Redshank.

There seem to be only two records of this redshank from Nepal. The first one was by Hodgson (Gray & Gray, 1846, p. 139), and the last, by Ripley (1950b, p. 368) who found it between December and February both in western (Karnali river) and in eastern (Kosi river) Nepal.

*172. **Tringa totanus eurhinus** (Oberholser). Eastern Redshank.

The only post-Hodgsonian record of the Eastern Redshank is due to Rand & Fleming (1957, p. 66) who took a specimen at Pokhara (*c.* 915 m.), west-central Nepal, in December.

*173. **Tringa nebularia** (Gunnerus). Greenshank.

Scully (1879, p. 358) noted it as fairly common from September through winter in central Nepal (plains and tarai, Nawakot district, Nepal Valley). Proud (1955, p. 72) observed it common in the Nepal Valley only on autumn migration (August-September). Ripley (1950b, p. 368), and Rand & Fleming (1957, p. 66) found it in both the western and eastern lowlands in winter.

174. **Tringa ochropus** Linnaeus. Green Sandpiper.

NEPAL VALLEY : Kathmandu (Bagmati and Bishnumati rivers), Thankot : 2 ♂♂, 1 ♀, 1 unsexed (March 19, April 14, 28).

The Green Sandpiper was found by us in small numbers on the rivers of the Nepal Valley during late March and April. It would appear that its numbers had already dwindled by mid-March. By the end of April, the majority had left for the breeding quarters.

Lowndes (1955, p. 37) noted it singly on several occasions at Bagra, Marsiyandi Valley, central Nepal, in July.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	140, 145	55, 57	40, —
1 ♀ :	139	57	40
1 unsexed :	145	61	42.5

*175. **Tringa glareola** Linnaeus. Wood Sandpiper.

The post-Hodgsonian records of the Wood Sandpiper from Nepal consist of Proud's (1955, p. 72) who found it common in the Nepal Valley on passage in autumn and spring, and Rand & Fleming's (1957, p. 67) who noted it occasionally in the lowlands of both west-central and eastern Nepal during winter.

176. **Actitis hypoleucos hypoleucos** (Linnaeus). Common Sandpiper.

NEPAL VALLEY : Kathmandu, Thankot : 2 ♀♀ (April 12, 25).

The Common Sandpiper is fairly common on the rivers of the Nepal Valley in spring. It is generally found singly along the edges of water.

Ripley (1950b, p. 368) and Rand & Fleming (1957, p. 67) found it in the western and eastern lowlands in winter ; and Biswas (1960a) recorded it at *c*. 855 m. in Chautara district, central Nepal, on January 27.

My April 12 specimen has the wings in moult.

The specimen taken on April 25 had somewhat enlarged ovary, with the ova of the size of mustard seeds, the largest one being 2 mm.

Colours of soft parts : Iris dark brown ; bill greenish horny, with almost black anterior third and very pale sides of the middle part of the lower mandible ; legs and feet dull greenish grey ; claws horny ; pads dull greenish grey.

Measurements : 2 ♀♀ : Wing 116, — ; tail 54, 60 ; bill 28, 30.

177. **Gallinago solitaria solitaria** Hodgson. Solitary Snipe.

CHITLANG VALLEY : Chitlang : 1 ♀ (April 19).

This was the only specimen of the Solitary Snipe found by us in Nepal. However, Scully (1879, p. 354) noted it to be not uncommon in the Valley from October to March, and Stevens (1925c, p. 892) found it on Singalila Range, eastern Nepal, at *c.* 3050 m. in January. Neither Ripley (1950b), nor Rand & Fleming (1957) record it from Nepal.

Measurements : 1 ♀ : Wing 167; tail 72; bill 83.

*178. **Gallinago nemoricola** Hodgson. Wood Snipe.

The Wood Snipe was not found by us, or by Rand & Fleming (1957) in Nepal. Scully (1879, p. 353) noted it to be rare in the Nepal Valley, having seen it there only twice in winter. Mr. Kilbourne, as reported by Ripley (1950b, p. 368), found it in the Valley in small numbers.

*179. **Gallinago stenura** (Bonaparte). Pintail Snipe.

We did not come across the Pintail Snipe in Nepal, nor did Rand & Fleming (1957). Scully (1879, p. 354), and Proud (1949, p. 718), however, reported it on passage in the Nepal Valley where many birds stay on for the winter.

*180. **Gallinago gallinago gallinago** (Linnaeus). Fantail Snipe.

Neither Rand & Fleming (1957) nor we found this snipe in Nepal. Scully (1879, pp. 355-356) and Proud (1949, p. 718) both noted it mainly on passage in the Nepal Valley, although many birds stay on there for the winter. Scully further observed that it was much less common than the Pintail Snipe. Ripley (1950b, p. 368) reports that Mr. Kilbourne, on the other hand, found the Fantail to be the commonest of the snipes in the Valley.

*181. **Gallinago minima** (Brünnich). Jack Snipe.

We were unable to find the Jack Snipe in Nepal, neither were Rand & Fleming (1957). Scully (1879, p. 356) observed it mainly on passage in the Nepal Valley where many examples spent the winter, and in the Nawakot district in November. Proud (1949, p. 718), however, describes it as a scarce passage migrant in the Valley where a few probably spend the winter.

182. **Scolopax rusticola rusticola** Linnaeus. Woodcock.

NEPAL VALLEY : Thankot : 1 ♀ (April 6).

We found the Woodcock rather rare in central Nepal during spring and summer. This specimen was taken in a small swampy patch in the forest off Thankot.

Scully (1879, p. 353) reported that the Woodcock left the Valley at the end of February, and Proud (1949, p. 718) found it as a scarce winter visitor there. Ripley (1950b, p. 368) saw and trapped it in eastern Nepal at *c.* 2745 m. in winter. Lowndes (1955, p. 37) observed it 'roding' on May 25 at *c.* 1980 m. in the Marsiyandi Valley, central Nepal. Rand & Fleming (1957, p. 67) obtained specimens in the Nepal Valley in January, and in eastern Nepal at *c.* 2895 m. in December. Biswas (1960a) saw it ' roding ' on a few occasions in Khumbu, eastern Nepal, at *c.* 3655 m. early in April.

Measurements : 1 ♀ : Wing 182 ; tail 76 ; bill —.

Resuscitation of Hodgson's name *Scolopax indicus*, 1837 (type locality Nepal) by Koelz (1954, p. 32) for the birds breeding ' throughout the Himalayas and to the east ' does not seem to be justified.

183. **Calidris minutus** (Leisler). Little Stint.

NEPAL VALLEY : Kathmandu : 1 ♀ (April 25).

This solitary specimen of the Little Stint was found in a flock of Temminck's Stint on Bagmati river. It was not reported from Nepal by Scully (1879), or Ripley (1950b), or Rand & Fleming (1957).

The wings of the specimen are in moult. The outermost primaries are still growing, but the other remiges have already moulted.

The specimen had a slightly swollen ovary with finely granular ova.

Colours of soft parts : Iris dark brown ; bill dark horny with greenish tinge on base ; legs and feet very deep greenish horny ; claws horny ; pads greenish grey.

Measurements : 1 ♀ : Wing — ; tail 39 ; bill —.

Gladkov (1957, pp. 195-203) has shown that *Calidris minuta* and *C. ruficollis* are two separate species.

184. **Calidris temminckii** (Leisler). Temminck's Stint.

NEPAL VALLEY : Kathmandu : 2 ♂♂, 3 ♀♀ (March 23, April 25).

Temminck's Stint is quite common in spring on the sandy banks and islands of Bagmati river in the vicinity of Kathmandu. In March and early April it was observed in flocks of a dozen birds or so in the morning, but later in the day and in the afternoon they moved away elsewhere. During the second week of April the flocks were found to be just beginning to break up into pairs.

Ripley (1950b) did not find it in Nepal. Rand & Fleming (1957, pp. 67-68) noted it in the western and eastern lowlands in winter.

Two of my specimens (1 ♂, 1 ♀) taken on March 23, have the rectrices in moult.

The March 23 specimens had the gonads but slightly enlarged (testes 2×1.5 each, ovary 5.5×4, finely granular), and the April 25 specimens had them more enlarged, the ovaries having coarsely granular ova.

Colours of soft parts : In March : Iris dark brown; bill black with pale horny on base of the upper mandible and pale yellowish brown on base of the lower mandible; legs and feet yellowish brown; claws black; pads yellowish brown.

In April : Iris dark brown ; bill black with greenish to dark greenish horny on basal half of the upper mandible and olive on basal third of the lower mandible; legs and feet olive to yellowish olive; claws black; pads olive brown.

Measurements:

	Wing	Tail	Bill
2 ♂♂:	95.5, 97	51.5, —	18, 20
3 ♀♀:	95, 101 (2)	49.5, 51	20, 20.5 (2)

*185. **Calidris alpinus** (Linnaeus) ? subspecies. Dunlin.

Hodgson's collection (Gray & Gray, 1846, p. 140) provides the sole record of the occurrence of the Dunlin in Nepal.

*186. **Philomachus pugnax** (Linnaeus). Ruff and Reeve.

We did not come across the Ruff and Reeve in Nepal, nor did Ripley (1950b) or Rand & Fleming (1957). Scully (1879, p. 357), and Proud (1955, p. 72) recorded this species in the Nepal Valley on passage in autumn.

Subfamily RECURVIROSTRINAE

*187. **Himantopus himantopus himantopus** (Linnaeus). Blackwinged Stilt.

*188. **Recurvirostra avosetta** Linnaeus. Avocet.

The only records of the Blackwinged Stilt and the Avocet from Nepal are based on Hodgson's collection (Gray & Gray, 1846, p. 138).

Subfamily IBIDORHYNCHINAE

*189. **Ibidorhyncha struthersii** Vigors. Ibisbill.

We did not find the Ibisbill in Nepal, nor did Scully (1879). Ripley (1950b, p. 368) observed it in the eastern tarai (Chatra) in February. Polunin (1955, p. 896) reported it from the Langtang Valley, central Nepal, from June to September. Rand & Fleming (1957, p. 68) found it at *c.* 760 m. in west-central Nepal in February. Biswas (1960a) observed it at *c.* 855 m. on Sun Kosi river at Dolalghat, Chautara district, central Nepal, in late January.

Subfamily ROSTRATULINAE

*190. **Rostratula benghalensis benghalensis** (Linnaeus). Painted Snipe.

Hodgson found it in the hills and plains of Nepal in winter (Gray & Gray, 1846, p. 140). It has not since been reported from that country.

Family GLAREOLIDAE

*191. **Cursorius coromandelicus** (Gmelin). Indian Courser.

After Hodgson's record (Gray & Gray, 1846, p. 131), the Indian Courser has been reported from Nepal only by Rand & Fleming (1957, p. 68) from the western tarai (once).

*192. **Glareola pratincola maldivarum** J. R. Forster. Large Indian Pratincole or Swallow-Plover.

The occurrence of the Large Indian Pratincole in Nepal is known only from Hodgson's collection (Gray & Gray, 1846, p. 131).

*193. **Glareola lactea** Temminck. Small Indian Pratincole or Sand Plover.

The post-Hodgsonian records of this pratincole from Nepal are Ripley's (1950b, p. 369) who saw it in the eastern tarai (Kosi river) in February, and Rand & Fleming's (1957, p. 68) who found it in the central dun at *c.* 760 m. in April.

Family LARIDAE

*194. **Larus ichthyaetus** Pallas. Great Blackheaded Gull.

The first and the only record of the Great Blackheaded Gull in Nepal has been provided by Rand & Fleming (1957, pp. 68-69) who occasionally found it along the larger rivers of the tarai in winter.

*195. **Larus brunnicephalus** Jerdon. Brownheaded Gull.

Hodgson's single specimen (Salvin, 1896, p. 218) forms the sole record of the Brownheaded Gull from Nepal.

*196. **Larus ridibundus** Linnaeus. Blackheaded Gull.

Salvin (1896, p. 215) listed a single Hodgson skin of the Blackheaded Gull from Nepal in the British Museum ; but in Gray & Gray's catalogue (1846, p. 148) of Hodgson's collection, this species was mixed up with *L. brunnicephalus.* The only other record from Nepal has been made by Rand & Fleming (1957, p. 69) who occasionally found it on the rivers of the lowlands in winter.

*197. **Sterna aurantia** J. E. Gray. Indian River Tern.

Neither Ripley (1950b), nor we came across the Indian River Tern in Nepal, but Scully (1879, p. 364) found it in the Nepal Valley on passage in early winter and early summer ; Rand & Fleming (1957, p. 69) recorded it as a common bird of the lowlands in winter ; and Biswas (1960a) found it on Arun river, eastern Nepal, at *c.* 670 m. in June.

*198. **Sterna hirundo tibetana** Saunders. Tibetan Tern.

The only record of the Tibetan Tern from Nepal has been furnished by Proud (1955, p. 72) who found it in the Nepal Valley on autumnal migration when it sometimes remained there for a day or two.

*199. **Sterna acuticauda** J. E. Gray. Blackbellied Tern.

Although the Blackbellied Tern was not listed in Gray & Gray's (1846) catalogue, a single skin from Nepal, presented by Hodgson, is included in Salvin's (1896, p. 45) catalogue. The two other records from Nepal are Rand & Fleming's (1957, p. 69) who found it fairly common in the tarai during winter, and Biswas's (1960a) who noted it on Arun and Sabhaya rivers, eastern Nepal, at *c.* 670-760 m. in June.

Order COLUMBIFORMES

Family PTEROCLIDAE

*200. **Pterocles exustus erlangeri** (Neumann). Common Sandgrouse.

*201. **Pterocles indicus indicus** (Gmelin). Painted Sandgrouse.

Both these sandgrouse are known from Nepal only through Hodgson's collection (Gray & Gray, 1846, p. 129).

*202. **Pterocles orientalis orientalis** (Linnaeus). Imperial Sandgrouse.

Hodgson's single specimen (Gray & Gray, 1846, p. 129 ; Ogilvie-Grant, 1893, p. 21), obviously a stray bird, forms the sole record of the Imperial Sandgrouse in Nepal.

Family COLUMBIDAE

203. **Treron apicauda apicauda** Blyth. Pintailed Green Pigeon.

Treron apicauda 'Hodgson' Blyth, 1845, *J. Asiat. Soc. Beng.* **14** : 854. ('Southeastern Himalaya and hill ranges of Assam, common at Darjeeling', hereby restricted to Darjiling, West Bengal.)

DUN : Hitaura : 3 ♂♂, 1 ♀, 1 juv. ♀ (May 12—June 2).

The Pintailed Green Pigeon appears rather scarce in Nepal. We found it in small numbers only in the central dun. It was observed partial to forests on hills and tall trees with dense foliage. Ours appears to be the only post-Hodgsonian record of this species from Nepal.

The juvenile female specimen has the feathers of the back with greyish centres, and its central rectrices are not so narrow as those of the adult.

Measurements :

	Wing	Tail	Rhamphotheca
3 ♂♂ :	164+, 176, 177	182, —, 184	10, 10.5 (2)
1 ♀ :	166	174+	10

The tail measurements of males as given by Baker (1928, p. 199) appear too large.

The nominate subspecies intergrades with *laotinus* in Assam (Margherita, Khasi Hills, Cachar) and north-western Burma (Chindwin, Myitkina).

204. **Treron sphenura sphenura** (Vigors). Wedgetailed Green Pigeon.

Vinago sphenura Vigors, 1831, (1832), *Proc. zool. Soc. Lond.* (1):173. (Himalayas = Darjiling, according to Baker, 1922e, p. 832.)

DUN : Hitaura, Bhimphedi : 4 ♂♂, 3♀♀ (March 13, May 5-19, June 1). CHITLANG VALLEY : Chitlang : 4♂♂, 3♀♀ (April 8-27).

The Wedgetailed Green Pigeon is a common bird of central Nepal from the Nepal Valley down to the dun. Ripley (1950b, p. 369) found it in eastern Nepal in winter, and Biswas (1960a) in summer, although Rand & Fleming (1957, p. 69) noted it to be absent in the hills of both western and eastern Nepal in winter. Lowndes (1955, p. 36) reported it to be common in Manangbhot, central Nepal, at *c.* 2440 m. in August.

Measurements :

	8 ♂♂	6 ♀♀
Wing :	176, 180, 181, 182 (2), 187, 188, —	171, 172, 173, 175, 176, 179
Tail :	126+, 129, 130 (2), 134, 135, 140, 145	124 (3), 125, 126,—
Rhamphotheca :	9.5 (2), 10 (3), 11, —(2)	9 (3), 9.5,—(2)

*205. **Treron curvirostra nipalensis** (Hodgson). Thickbilled Green Pigeon.

This green pigeon was not found in Nepal by Scully (1879) or Ripley (1950b) or by us. Polunin (1955, p. 895) obtained it in summer at *c.* 2745 m. in the Langtang Valley, central Nepal, and Rand & Fleming (1955, pp. 69-70) reported it as an uncommon bird in the central lowlands in April.

*206. **Treron pompadora conoveri** Rand & Fleming. Conover's Green Pigeon.

Rand & Fleming (1953, p. 201 ; 1957, p. 70), who discovered this race, are the first to report the occurrence of this species in Nepal. They found it in winter in flocks of 4-15 in heavy forest in the tarai of west-central Nepal.

*207. **Treron bicincta bicincta** (Jerdon). Orangebreasted Green Pigeon.

The earlier collection of Hodgson (Gray & Gray, 1846) did not contain this green pigeon, but his later collection which contained birds from Nepal as well as from other places, included this species (Gray, 1863, p. 66). The first definite Nepali record of the species is owed to Rand & Fleming (1957, p. 70) who occasionally found it in winter in the west-central lowlands.

208. **Treron phoenicoptera phoenicoptera** (Latham). Bengal Green Pigeon.

Dun : Hitaura : 7 ♂♂, 1 juv. ♂ (June 7, 16-19, July 14-29).

The Bengal Green Pigeon is common in the central dun particularly on fruit-bearing *Ficus* trees. Ripley (1950b, p. 369), and Rand & Fleming (1957, p. 70) found it in lower elevations of western and west-central Nepal, respectively.

The juvenile specimen (♂) has brown primaries.

One of my adult males (June 7) had somewhat enlarged testes, the right one measuring 11.5 × 5.5 mm., and the left, 9.5 × 6 mm.

Measurements : 7♂♂ : Wing 190, 192, 194, 196, 198, 200 (2) ; tail 112, 113, 115, 119, 120, 122 (2) ; rhamphotheca 12, 13 (2), 13+, 13.5, —(2).

[**Ducula aenea sylvatica** (Tickell). Green Imperial Pigeon.

Baker (1928, p. 208) included Nepal within the range of the Green Imperial Pigeon, presumably based on a specimen in the British Museum (ex Salvin-Godman Collection) which doubtfully came from Nepal (Salvadori, 1893, p. 193). Baker's action has, however, been followed by Peters (1937, p. 46) and Ripley (in press). Although the possibility of its occurrence in Nepal cannot be denied, I am unable to trace any authentic report to that effect.]

*209. **Ducula badia insignis** Hodgson. Imperial Pigeon.

The Imperial Pigeon has not been reported from Nepal since Hodgson's days.

*210. **Columba leuconota leuconota** Vigors. Snow Pigeon.

Neither Ripley (1950b), nor Rand & Fleming (1957) or we found the Snow Pigeon in Nepal. Scully (1879, p. 340) reported it from ' the upper northern regions of Nepal '. Smythies (1948, p. 442) found it in autumn at *c.* 4570 m. in the Gandak-Kosi watershed, central Nepal. Polunin (1955, p. 895) noted it to be quite common in summer above forest zone up to *c.* 4875 m. or more in the Langtang Valley, central Nepal. He further reported of a flock that remained all August at *c.* 3350 m. Lowndes (1955, p. 36) found it in summer to be very common between *c.* 3350 m. and 4725 m. and less common higher up in the Manangbhot area, central Nepal. Biswas (1960a) observed it at *c.* 2285-3050 m. in February and later up to April between *c.* 3655 and 4875 m. in Khumbu, eastern Nepal.

211. **Columba livia intermedia** Strickland. Indian Blue Rock Pigeon.

Dun : Hitaura : 1 ♂ (May 28). Nepal Valley : Kathmandu, Thankot : 2 ♂♂, 2 ♀♀ (March 21-27).

The Blue Rock Pigeon is commonly found in flocks from the central dun up to the Nepal Valley, in and around villages and towns, as well as about cultivated fields.

Lowndes (1955, p. 36) reported it to be common in summer at *c.* 3050-3960 m. in Manangbhot, central Nepal, and Rand & Fleming (1957, pp. 70-71) at *c.* 915 m. and *c.* 2805 m. in winter in west-central Nepal.

My female specimen from Kathmandu (March 21) had granular ovary. This specimen still has some amount of juvenile plumage. There is much brown on wing coverts and breast, very little metallic purple and green, not very dark black bands on secondaries, browner primaries, and lower breast and abdomen ashy with a few brown feathers. There is no sign of moult.

The male specimen from Hitaura (May 28) has well-developed testes, measuring 14 × 7.5 mm. (right).

Measurements :

	Wing	Tail	Rhamphotheca
3 ♂♂ :	220, 221, 227	111, 114, 117	10, 10.5, 11.5
2 ♀♀ :	213, 216	102, 105	10, 10.5

*212. **Columba palumbus casiotis** (Bonaparte). Wood Pigeon.

Although Nepal falls within the range of the Wood Pigeon, it has not been included in any of the lists of Nepal birds, nor has it been observed by us. Salvadori (1893, p. 303), however, mentioned one specimen from that country, presented by Hodgson to the British Museum.

213. **Columba arquatrix hodgsonii** Vigors. Speckled Wood Pigeon.

Columba Hodgsonii Vigors, 1832, *Proc. zool. Soc. Lond.* (2):16. (Himalayas= Nepal, according to Baker, 1922e, p. 834.)

NEPAL VALLEY : Thankot : 1 ♂ (April 4).

The Speckled Wood Pigeon did not appear to be a common bird in central Nepal. A pair was seen by us once in the forest at Thankot in April, and a small flock at Godavari in May.

Scully (1879, p. 339) noted it to be a winter visitor (December to February) to the foot of the hills round the Nepal Valley where it was common at certain places. Ripley (1950b, p. 369) found it only in the Valley and only in April-May, thus corresponding with our observation. Lowndes (1955, p. 36) saw several birds in summer at *c.* 3050 m. in Manangbhot, and Proud (1955, p. 71) found it common in the Nepal Valley. Rand & Fleming (1957) did not come across it.

Measurements : 1 ♂ : Wing 228 ; tail 150 ; rhamphotheca 10.

Recently, Goodwin (1959, p. 14) suggests that *C. arquatrix* and *C. hodgsonii* should be treated as two distinct species.

214. **Columba pulchricollis** Blyth. Ashy Wood Pigeon.

DUN : Bhimphedi : 1 ♂ (May 10).

The Ashy Wood Pigeon does not appear to be a common bird in Nepal. It was seen by us only on a few occasions on the Mahabharat Range in dense forests.

Ripley (1950b, pp. 369-370) found it not uncommon in the heavily wooded parts of the Nepal Valley. He also recorded it from eastern Nepal. Proud (1955, p. 71) found it scarce in the Valley. Rand & Fleming (1957, p. 71) reported it only from the heavily wooded regions of west-central Nepal. Scully (1879) did not include it in his list.

Measurements : 1 ♂ : Wing 210 ; tail 126 ; rhamphotheca 10.

215. **Macropygia unchall tusalia** (Blyth). Bartailed Cuckoo-Dove.

DUN : Hitaura : 1 ♂ (May 15). NEPAL VALLEY : Thankot : 1 ♀ (March 26).

The Bartailed Cuckoo-Dove was found by us in small numbers in the Nepal Valley in forests at the base of the Chandragiri near Thankot, and of the Phulchauki Danda about Godavari during March-May. It was observed again in the central dun around Hitaura in May-June.

Ripley (1950b, p. 370) recorded it from the Chandragiri Pass above Thankot, and in eastern Nepal at *c.* 2440 m. Neither Scully (1879), nor Rand & Fleming (1957) found it in Nepal.

Measurements :

	Wing	Tail	Rhamphotheca
1 ♂ :	203	202	7
1 ♀ :	194	187	7

216. **Streptopelia orientalis meena** (Sykes). Western Rufous Turtle Dove.

217. **Streptopelia orientalis agricola** (Tickell). Eastern Rufous Turtle Dove.

BHABAR : Amlekhganj : 1 ♂ (March 10). DUN : Hitaura : 1 ♂, 1 juv. ♂ (June 9, 15). CHITLANG VALLEY : Chitlang, 2 ♀♀ (April 17). NEPAL VALLEY : Thankot : 6 ♂♂, 2 ♀♀ (March 20—April 4).

The Rufous Turtle Dove is a common bird in central Nepal. It is, however, not so common in the bhabar in spring and the dun in summer as it is in the Nepal Valley during March-May. It is usually found in the opener parts of forests, sometimes about villages.

Scully (1879, p. 341) found it throughout the year in the Valley where Proud (1949, p. 718), however, notes it only as a summer visitor (mid-March onwards). Lowndes (1955, p. 36) found it up to *c.* 3960 m. during summer in Manangbhot, central Nepal. In eastern Nepal, Ripley (1950b, p. 370) found it in the Arun watershed in winter from *c.* 305 to 2590 m. Biswas (1960a) recorded it in April-May between *c.* 3050 and 3960 m. in Khumbu and in June at *c.* 1525 m. in the Arun watershed. It would appear that the highest altitudinal limits of *meena* and *agricola* should be raised from the usually accepted *c.* 2745 m. (Ripley, in press) to *c.* 3960 m.

Most of my March and April specimens were breeding.

The juvenile male bird (June 15) is in very worn plumage.

Measurements :

	8 ♂♂	4 ♀♀
Wing :	180 (2), 182, 187, 188, 193, 197 (2)	185, 187, 190, 195
Tail :	122 (2), 125, 129, 135, 136, 138, 140	123, 126, 130 (2)
Rhamphotheca :	8 (4), 8.5, 9, — (2)	8, 8.5 (2), 9

From an examination of breeding examples, it appears that *S. o. meena* intergrades with *agricola* in central Nepal. One may find there all gradations from true *meena* to true *agricola*, especially with regard to the colour of the under tail coverts, contrary to Rand & Fleming's (1957, p. 71) conjecture (see also Scully, 1879, p. 341). The position, of course, is not quite so easy or clear when all birds are taken into consideration, for, as has been rightly suspected by Rand & Fleming, migrants, particularly early comers and late goers, complicate the picture considerably. However, so far as breeding populations in Nepal are concerned, I think the following working arrangement should prove satisfactory :

Western and west-central Nepal : *S. o. meena*
Central Nepal : *S. o. meena* $\gtrless$ *agricola*
Eastern Nepal : *S. o. agricola*

It may incidentally be noted that my casual study based mainly on the materials of the American Museum of Natural History and the British Museum as presented above, is in fair agreement with Roonwal's (1941, p. 331) observation based on the Indian Museum material.

Both Ripley and Rand & Fleming identified their breeding specimens from the Nepal Valley as *meena*. Their few examples, like some of mine and Scully's and Bailey's (at the British Museum), must be towards the *meena*-side of intergradation. The taxonomy of the species *S. orientalis* poses an intriguing problem, especially in its Indian populations, which only a thorough revisional study can solve.

218. **Streptopelia decaocto decaocto** (Frivaldszky). Indian Ring Dove.

CHITLANG VALLEY : Chitlang : 1 ♂, 1 ♀ (April 27).

The Ring Dove was not met with by us in the Nepal Valley where Proud (1955, p. 71) found it, though not normally, at the end of the monsoon in flocks feeding on paddy. However, we came across a few about cultivated fields in the Chitlang Valley, and scarcely in the central dun. All other workers reported this species only from the plains to the duns.

Measurements :

	Wing	Tail	Rhamphotheca
1 ♂ :	172	134	—
1 ♀ :	171	130	9

Compared with the populations from Iran and Afghanistan, the Indian birds are a trifle darker, with a little more grey on the lower plumage.

219. **Streptopelia tranquebarica humilis** (Temminck). Eastern Red Turtle Dove.

DUN : Hitaura : 5♂♂, 1 juv. ♂, 3 ♀♀ (May 21, June 15-23, July 10-12).

The Red Turtle Dove is not an uncommon bird in the duns of central Nepal during summer. It usually occurs in pairs or in small loose parties, feeding in the forest clearings, such as cut-up patches, forest paths, etc.

Scully (1879, p. 342) found it common in the central bhabar and dun in winter. Proud (1949, p. 718) noted it as a summer visitor, though not very common, in the Nepal Valley. Ripley (1950b) and Rand & Fleming (1957) did not record it from Nepal.

Most of my June and July specimens are worn, a few very much so. A male bird (June 15) has moulting upper tail coverts and central tail feathers, while a female (June 20) has only the upper tail coverts in moult.

Measurements :

	Wing	Tail	Rhamphotheca
5 ♂♂ :	136 (2), 140 (2), 141	86+, 89+, 90, —(2)	7, 7.5, 8, — (2)
3 ♀♀ :	136 (2), 141	83+, 87, —	7, 8.5, —

I agree with Whistler & Kinnear (1936, p. 680) in not recognizing Bonaparte's *murvensis* (=Hartert's *murmensis*), since the birds from Nepal differ very little, if at all, from those of Assam and Burma. However, there appears to be scope for further detailed study of the western and southern Indian populations, especially of their breeding ranges and movements during the non-breeding season. It may be mentioned in this connexion that in southern India where the type locality of the nominate subspecies lies, two distinct forms occur. Thus, of the four southern specimens I have examined (two from Mysore and two from Coimbatore), three are very close to Sikkim-Assam birds, that is *humilis*, while the fourth one matches well with Panjab-Uttar Pradesh birds. But this specimen could as well be a migrant from the north, it being taken on December 17.

Standard works on Indian ornithology, such as those of Baker (1928, p. 251), Peters (1937, p. 97), and Ripley (in press), have all mentioned ' western Nepal ' within the range of the nominate subspecies. Although the western Nepali birds may possibly belong to that subspecies, I am unable to trace any reported collection of actual specimen of the species from that part of the country.

220. **Streptopelia chinensis suratensis** (Gmelin). Indian Spotted Dove.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 9, 10). DUN : Hitaura, Paharé Ghat : 3 ♂♂, 1 ♀, 2 juv. ♀♀ (May 25-28, June 10-13). NEPAL VALLEY : Kathmandu and its suburbs, Thankot : 6 ♂♂, 1 subad. ♂, 8 ♀♀, (March 20-April 23).

The Spotted Dove is one of the commonest birds of central Nepal from the bhabar up to the Nepal Valley, particularly in and around fields of paddy and pulses.

One of my adult female specimens (Kathmandu, March 24) has a few faint blackish bars on the breast, abdomen, flanks and under tail coverts. The subadult male specimen (Thankot, April 2) has the underside brownish vinous and its wing coverts are edged with rufous.

The subadult male has the upper tail coverts, a female (Kathmandu, March 20) both the rump and upper tail coverts, and a male (Hitaura, June 22) the central rectrices, in moult.

Colours of soft parts : Iris pinkish red; orbital skin and edges of eyelids pink; bill black; legs and feet dull purplish red; claws dark horny; pads white.

All the adult examples taken between March and June had breeding gonads.

Measurements : 11 ♂♂ : Wing 135, 137, 138, 142 (3), 143, 144, 146, 151, — ; tail 131, 136 (4), 137+, 138, 143, 144, 148, 150 ; rhamphotheca 7.5 (2), 8 (4), 8.5 (2), 9, —(2).

10 ♀♀ : Wing 133, 135, 136, 138.5, 139, 140, 141 (2), 143, 145 ; tail 125, 130, 131, 132, 134 (2), 135, 139, 140, 141; rhamphotheca 7.5 (3), 8 (5), 8.5, —.

221. **Chalcophaps indica indica** (Linnaeus). Indian Emerald Dove.

Bhabar : Amlekhganj : 1 ♂ (March 10). Dun : Hitaura : 5 ♂♂, 2 ♀♀ (May 12-29).

The Emerald Dove is not uncommon in the forests of the bhabar and dun of central Nepal. Scully (1879) did not report it from Nepal.

One of my female specimens (May 12) has chestnut central rectrices.

Measurements :

	Wing	Tail	Rhamphotheca
6 ♂♂ :	148, 149, 151, 152, 153, 156	92 (2), 93, 94, 95, 99	9 (3), 9.5, — (2)
2 ♀♀ :	140, 144	87, 89	8, 8.5

Order PSITTACIFORMES

Family Psittacidae

222. **Psittacula eupatria nipalensis** (Hodgson). Large Indian Parakeet.

Tarai : Simra : 1 ♂ (March 5). Bhabar : Amlekhganj : 1 ♂, 1 ♀ (March 10).

The Large Indian Parakeet occurs in small numbers in the forests of the tarai and bhabar of central Nepal. Although Scully (1879, p. 240) reported it from the dun, we failed to find any there. Ripley (1950b, p. 371) and Rand & Fleming (1957, p. 72) recorded it from the lowlands of western and west-central Nepal.

Measurements :

	Wing	Tail	Culmen from cere
2 ♂♂ :	224, 234	345+, —	35, 37
1 ♀ :	215	295+	34

223. **Psittacula krameri borealis** (Neumann). Northern Indian Roseringed Parakeet.

Tarai : Simra : 1 ♂, 1 ♀ (March 4, 5). Bhabar : Amlekhganj : 1 ♂, 2 ♀♀ (March 10, June 8).

The Roseringed Parakeet is common in the tarai and bhabar in light forests and near villages.

The June specimens (1 ♂, 1 ♀) had non-breeding gonads.

Colours of soft parts : Iris pale yellow; upper mandible coral red with black tip; lower mandible black on anterior third and mixed black and red or dusky red posteriorly; legs and feet greenish slaty; claws black; pads greenish grey.

Measurements :

	Wing	Tail	Culmen from cere
2 ♂♂ :	171, 173	243, —	24 (2)
3 ♀♀ :	165, 169, 174	222+, — (2)	22, 23, 24

224. **Psittacula alexandri fasciata** (P. L. S. Müller). Indian Redbreasted Parakeet.

Psittacus fasciatus P. L. S. Müller, 1776, *Vollstädiges Natursyst.*, Suppl., : 74. (Pondicherry, South India, error, fixed at Arakan, Burma, by Ticehurst, 1933, p. 934, but see discussion below.)

Bhabar : Amlekhganj : 1 ♂, 2 ♀♀ (March 10). Dun : Hitaura 2 ♂♂, 1 juv. ♀ (May 19, June 16, July 14).

The Redbreasted Parakeet was found by us in the forests of the bhabar and dun of central Nepal in flocks of about a dozen or more. Scully (1879, p. 244) recorded it from the Nepal Valley in August-October, where subsequent workers failed to find it. Rand & Fleming (1957, p. 73) found it in west-central Nepal between *c.* 1220 and 1525 m. in winter. It is not included in Ripley's (1950b) list.

The juvenile female specimen (July 14) is green all over, and is evidently a bird of the year.

Measurements :

	Wing	Tail	Culmen from cere
3 ♂♂ :	168, 169, 171	151+, 174+, —	24, 25, 26.5
2 ♀♀ :	164, 165	150, —	24 (2)

The type locality of *Psittacus fasciatus* as given by Müller, namely Pondicherry, was evidently an error, and Ticehurst (loc. cit.) fixed it as Arakan. Müller's description of the species was based on Daubenton's *Planches enluminees*, pl. 517, which was published in 1770. The specimen(s) on which the plate was based, was collected probably before 1762 (Stresemann, 1952, p. 502). Now, Arakan was practically unknown to Europeans even in 1776, so that unless it can be proved beyond any reasonable doubt that the original specimen(s) did actually come from Arakan, it seems reasonable to attach no importance to Ticehurst's arbitrary fixation of the type locality. It may be pointed out here that Chandernagore in Bengal was in French possession during those days and earlier, and it certainly was not very difficult for a French naturalist or collector stationed there to obtain specimens from the Himalayan foothills and duars in northern Bengal. The other possibility is that the original specimen(s) did not come from India or Upper Burma at all, but from some other area within the range of the species, visited by early French collectors.

225. **Psittacula cyanocephala bengalensis** (Forster). Northern Indian Blossomheaded Parakeet.

BHABAR : Amlekhganj : 2 ♂♂, 1 ♀ (March 10). DUN : Hitaura : 1 ♂, 3 juv. ♂♂ 1 juv. ♀ (May 28, 30, June 7, 26, July 23).

The Blossomheaded Parakeet was found by us in the forests of only the bhabar and dun of central Nepal.

Although Scully (1879, p. 242) did not find it in the Nepal Valley 'except probably as a mere straggler', Proud (1949, p. 715) noted it to be moderately common on the hills round the Valley. It was not found there by Ripley (1950b, p. 371) who reported it from eastern Nepal from the tarai up to *c.* 1830 m., nor by Rand & Fleming (1957, p. 73) who found it only in the lowlands of west-central and eastern Nepal.

The juvenile specimens are all birds of the year. Of them, two males May 30, July 23) and a female (June 7) are in the first stage plumage. The other male specimen (May 28) is moulting from the first to the second stage.

The adult male bird from Hitaura (June 26) is very worn.

Measurements :

	Wing	Tail	Culmen from cere
3 ♂♂ :	141, 143, 144+	207, — (2)	18.5, 19 (2)
1 ♀ :	138	200	18

Rand & Fleming (1957, pp. 73-74) suggest synonymizing *rosa* and *bengalensis* with *cyanocephala*, with which I am unable to agree.

Nepal has been included within the range of the allied species *Psittacula roseata* Biswas (*rosa* or *bengalensis* of authors, not of Boddaert or Forster, respectively) by Baker (1927, p. 206), presumably on the basis of Salvadori's (1891, pp. 454-455) identification of Hodgson's specimens. However, such of those specimens as could be traced are all worn examples of *Ps. cyanocephala*.

226. **Psittacula himalayana** (Lesson). Slatyheaded Parakeet.

BHABAR : Amlekhganj : 2 ♂♂ (March 8, 9). DUN : Hitaura : 1 ♂ (May 24). NEPAL VALLEY : Thankot : 1 ♂, 1 juv. ♂ (April 4, 14).

The Slatyheaded Parakeet is found in small flocks in light forests of central Nepal. It does not appear to be common anywhere.

Scully (1879, p. 243) reported it only from the Nepal Valley between December and April. Proud (1949, p. 715) also noted it in the Nepal

Valley, and on the lower hills around. Ripley (1950b, p. 371) found it only once and that was in western Nepal at *c.* 1525 m. in December. Rand & Fleming (1957, p. 74) recorded it from *c.* 1370-2135 m. in west-central and central Nepal in winter. We found it, as mentioned above, between *c.* 245 and 1525 m. in central Nepal in March-May. Incidentally, the lowest altitude for this bird has been given by Ripley (in press) as *c.* 610 m.

The juvenile specimen (April 14) is green all over, and is very worn. The adult bird from Hitaura (♂, May 24) is also worn.

Measurements : 4 ♂♂ : Wing 158+, 160, 165, 168 ; tail —, 223, 224, 243 ; culmen from cere 21(2), 21.5, 23.

I agree with Husain (1959, p. 249) in treating *Ps. himalayana* as a species distinct from *Ps. finschi* (Hume).

*227. **Loriculus vernalis vernalis** (Sparrman). Indian Lorikeet.

Although the standard works on Indian avifauna, e.g. Baker (1927, p. 217), Peters (1937, p. 256), and Ripley (in press) do not include Nepal within the range of this species, Hodgson presented two skins from the 'Tarai of Nepal' to the British Museum (Gray & Gray, 1846, p. 113). It has not since been reported from Nepal, however.

Order CUCULIFORMES

Family CUCULIDAE

228. **Clamator coromandus** (Linnaeus). Redwinged Crested Cuckoo.

Dun : Hitaura : 5 ♂♂, 3 ♀♀ (May 12-June 5).

The Redwinged Crested Cuckoo is fairly common in the dun during summer in dense as well as light forests, sometimes even in thorny undergrowths and bushes. It is rather noisy, and occurs singly or in loose parties of three or four.

We were not able to locate it in the Nepal Valley where Scully (1879, p. 257) who noticed it at Godavari in May, thought it bred. Neither Ripley (1950b), nor Rand & Fleming (1957) recorded it from Nepal.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	160.5, 162, 163, 165.5, 166	238, 243+, 251,— (2)	31.5, 32 (2), 33, 33.5
3 ♀♀ :	164, 165, 168	240+, 248+, 258	32 (2), 34

229. **Clamator jacobinus serratus** (Sparrman). Pied Crested Cuckoo.

Dun : Hitaura : 1 ♂, 1 ♀ (June 21, 23).

The Pied Crested Cuckoo appears to be rather scarce in central Nepal. We came across only a few individuals in the forests at Hitaura in the dun. Scully (1879), Ripley (1950b) and Rand & Fleming (1957) failed to find it in Nepal; and Proud (1949, p. 714) saw it only once at Kathmandu, Nepal Valley, in April.

Measurements :

	Wing	Tail	Bill
1 ♂:	148	170	28
1 ♀:	143	150+	26.5

230. **Cuculus sparverioïdes sparverioïdes** Vigors. Large Hawk-Cuckoo.

CHANDRAGIRI: above Thankot, above Chitlang, on the crest: 3 ♂♂ (April 6-22). Also one specimen without exact locality, date and sex.

The Large Hawk-Cuckoo is frequently heard from about the beginning of April on the ranges surrounding the Nepal Valley at *c.* 1675 m. upwards. It is also found on the Mahabharat Range in May. Nowhere, however, is it seen easily owing to the thick cover it selects. It has also been recorded in winter at *c.* 1830 m. in west-central Nepal by Rand & Fleming (1957, p. 74), and at *c.* 1525 m. in eastern Nepal in June by Biswas (1960a). Ripley (1950b) did not include it in his list.

One of my specimens (April 22) had the testes slightly enlarged, measuring 5×3.5 (right) and 6×4 (left) mm.

Colours of soft parts : Iris orange-yellow; edges of eyelids lemon yellow; upper mandible dark horny, paler on the tip; lower mandible greenish slaty, dusky on the sides of anterior half and on the tip; gape dull lemon yellow; legs and feet lemon yellow; claws pale horny with yellowish tinge; pads dirty lemon yellow.

Measurements :

	Wing	Tail	Bill
3 ♂♂:	213, 227, 228	202, 205, —	28, 29, —
1 unsexed:	225	—	30

231. **Cuculus varius varius** Vahl. Common Hawk-Cuckoo.

DUN: Hitaura: 3 ♂♂, 2 ♀♀, 1 juv. ♀ (May 19-28, June 6, 21).

This hawk-cuckoo is heard only sometimes in the Nepal Valley during April-May, but is fairly common during summer in the bhabar and dun. It is noticed around villages and the edges of forests.

It was reported breeding in small numbers in the Valley by Scully 1879, p. 256) who noted it there from February onwards. Proud (1949, p.714) recorded it to be scarce there. Ripley (1950b, p. 371) found it in the central plains (Birganj) in winter, and Rand & Fleming (1957, p. 75) in the lowlands in the same season.

The juvenile female specimen (June 21) has rufous bars next to black on tail, ill-defined rufous barrings on the upper side, and a rufous wash on the underside, heavily streaked with blackish brown.

Measurements :

	Wing	Tail	Bill
3 ♂♂:	205, 206, 213	174, 180, 188	28, 30, 31
2 ♀♀:	206, 207	177+, 179+	29 (2)

Regarding Hodgson's collection of *C. varius*, see note under the next form.

*232. **Cuculus fugax nisicolor** Blyth. Hodgson's Hawk-Cuckoo.

Hodgson's collection (Gray & Gray, 1846, p. 120 ; Gray, 1863, p. 66) provides the sole record of this hawk-cuckoo from Nepal. Gray & Gray, and Gray both listed Hodgson's specimens of this form and those of *C. varius* together. However, Shelley (1891, pp. 235, 238) gave four specimens of *varius* and two of *nisicolor* presented by Hodgson from Nepal.

233. **Cuculus micropterus micropterus** Gould. Indian Cuckoo.

Dun : Bhimphedi : 1 ♂, 1 ♀ (May 6, 10). Markhu Valley : Deorali : 2 ♂♂ (May 1). Chitlang Valley : Chitlang : 1 ♂ (April 16). Nepal Valley : Pashupatinath : 1 ♂ (April 28).

The Indian Cuckoo is common from the Markhu Valley to the Nepal Valley in April and May. In the upper parts of the central dun it is rather scarce in early May. We did not find it later in the bhabar and dun.

Scully (1879) did not report it from Nepal. Biswas (1960a) found it in the Arun watershed, eastern Nepal, at *c.* 1525 m. in June.

One of my male specimens (Deorali, May 1) still has traces of rufous on the upper parts.

In the male bird from the Nepal Valley, the testes had just commenced maturing.

Colours of soft parts : Iris reddish brown; edges of eyelids yellow; upper mandible dark horny with yellow on the base and gape; lower mandible pale grey with yellow on the base and dark horny on the tip; legs and feet yellow; claws dark horny; pads white.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	192, 195, 201, 204, 207	151, 159, 195+, 160,—	30, 31, 32 (2),—
1 ♀ :	207	161+	30

See note under *C. p. poliocephalus* (p. 543) regarding Hodgson's collection of *C. micropterus.*

234. **Cuculus canorus telephonus** Heine. Asiatic Cuckoo.

Dun : Hitaura : 2 ♂♂ (June 12, 21). Markhu Valley : Deorali : 1 ♂ (April Chitlang Valley : Chitlang : 1 ♂, 1 ♀ (April 16, July 2). Nepal Valley : Sheopuri Range off Burhanilkantha, Patan, Thankot : 4 ♂♂, 1 ♀ (April 12, May 2, 17).

The Asiatic Cuckoo is a common bird from the Mahabharat Range to the Nepal Valley during April-May. In the Valley it is found common in the central woods as also on the hills bordering it. In the central dun, however, it is quite scarce in May-June. The two specimens collected there by us in June might probably be late-comers from the winter quarters, or else breeding there, but no record of the condition of their gonads was unfortunately kept.

Stevens (1925b, p. 679) reported it from the Mai Valley, eastern Nepal, at *c.* 2745 m. Ripley (1950b) did not mention this species in his list. Polunin (1955, p. 895) occasionally heard it in the oak forests of the Langtang Valley, central Nepal, during June. Lowndes (1955, p. 35) found it plentiful and breeding at *c.* 3655-3960 m. in Manangbhot, central Nepal, during June-August. Biswas (1960a) found it common in eastern Nepal between *c.* 1220 and 2745 m. in June, but less common above up to *c.* 4265 m. in May.

One of my male specimens (May 2) has the throat feathers in moult.

The same specimen and another male (May 17) had the gonads just commenced swelling.

Colours of soft parts : Iris and edges of eyelids chrome yellow ; bill dark horny with yellow on the base and gape, and light grey with yellowish wash on the middle part of the lower mandible ; legs and feet yellow ; claws light grey ; pads white.

Measurements :

	8 ♂♂	2 ♀♀
Wing :	211, 215 (2), 223, 225, 226, 232, 243	217, 223
Tail :	—, 165, 167, 168, 172, 175, 183 (2)	163, 165
Bill :	26.5, 28 (2), 28.5, 29, — (3)	27.5 (2)

[cf. ♂♀ wing 220-227 ; tail 155-178, as given by Baker (1927, p. 137).]

This subspecies seems to be ill-defined indeed.

235. **Cuculus saturatus saturatus** Blyth. Himalayan Cuckoo.

DUN : Hitaura, Bhimphedi : 1 ♂, 1 juv. ♂, 1 ♀ (May 10, June 15, 17). MARKHU VALLEY : Deorali ; 1 ♂, 1 juv. ♀ (April 29, May 1). CHITLANG VALLEY : Chitlang : 1 ♂ (April 20). NEPAL VALLEY : Thankot, top of Chandragiri Range above Thankot, Godavari, Phulchauki Danda above Godavari : 9 ♂♂, 1 nestling ♂, 1 hepatic ♀ (March 29, April 4-16, May 10-12).

On the hills surrounding the Nepal Valley and on the Chitlang side of the Chandragiri, the Himalayan Cuckoo is very common from about the middle of April. Its characteristic four-noted sonorous call could be heard almost any time of the day, and even on moonlit nights. It is seldom seen below *c.* 1525 m.

The central dun birds taken in May and June might probably represent late-comers from the winter quarters.

It was not found in Nepal by Ripley (1950b). Biswas (1960a) reported it to be common between *c.* 1525 and 3050 m. in eastern Nepal in June.

Two of my males and the hepatic female, taken April 15, 16, May 12, had slightly enlarged gonads, the female having its largest ova measuring 4 and 6 mm.

The nestling (Godavari, May 10) was collected on the ground while it was being pecked at by four Redbilled Blue Magpies, apparently stolen from its foster-parent's care. It had severe injuries on the head (part of the brain was exposed), eyes and abdomen. It died soon after it was rescued from its predators.

One of the adult males (Hitaura, June 17) is in very worn plumage, except the central rectrices which are moulting.

HEPATIC FEMALE: Chin, throat and upper breast pale rufous with blackish brown bars, sides of the throat and of upper breast chestnut and blackish brown bars ; lower breast to under tail coverts white with blackish brown bars, with a slight rufous tinge on the vent and under tail coverts.

JUVENILE : Male, June 15.—General coloration dark grey-brown with white bars on the upper side, chin and throat.

Female, April 29.—Rufous with blackish brown bars all over.

NESTLING : Upper plumage and chin to breast blackish brown, with narrow white edges to feathers ; abdomen and vent faint fulvous heavily barred with broad bands of blackish brown ; primaries barred on the outer webs with rufous. Remiges and under wing coverts growing. Rectrices not yet developed.

Colours of soft parts : ADULT MALE : Iris reddish brown ; edges of eyelids yellow; upper mandible dark horny with pale yellow on the base, and greenish horny patches in front of nostrils (absent in one specimen) ; lower mandible pale greenish horny with yellow on the base, and dark horny on the edges of the anterior half and tip ; gape yellow (once orange-yellow) ; legs and feet yellow (legs once yellowish horny) ; claws horny with yellow on the tips (once fleshy) ; pads white.

HEPATIC FEMALE : Iris brownish yellow ; upper mandible dark horny, a little paler on the base, yellowish white patches in front of nostrils, and yellow on the sides below nostrils ; lower mandible horny with darker tip, and yellow on the base and sides of the proximal third ; legs and feet wax yellow; claws horny with yellow on the tips of the outer and inner ones. Eyelids, gape and pads as in adult male.

NESTLING : Iris dark brownish grey ; bill black ; legs fleshy ; feet yellowish fleshy ; claws fleshy ; pads yellowish fleshy.

Measurements :

	12 ♂♂	1 ♀	1 hep. ♀
Wing :	179+, 182, 183, 184, 185 (2), 186, 187 (2), 188, 192 (2)	186	180
Tail :	144, 145, 146+, 148, 149, 151+, 155, 156 (2),—(3)	159	147
Bill :	27, 27.5, 28 (5), 29, 30, — (3)	28	27

[cf. measurements given by Baker (1927, p. 141) : ♂♀ : wing 208-226; tail 151-176.]

Regarding Hodgson's collection of the Himalayan Cuckoo, see note under *C. p. poliocephalus* (below).

236. **Cuculus poliocephalus poliocephalus** Latham. Small Cuckoo.

MARKHU VALLEY : Deorali : 2 ♂♂ (April 28, 30). NEPAL VALLEY : Thankot : 1 ♀ (July 25).

The Small Cuckoo was seen by us only on a few occasions in deep gorges on the Chandragiri and Mahabharat ranges. It appears to be a very shy bird.

Scully (1879) did not find it in Nepal, nor was it reported thence by Rand & Fleming (1957). Stevens (1925b, p. 679) recorded it from the Mai Valley, eastern Nepal at *c.* 2135 m. in May. Ripley (1950b, p. 371) found a single specimen in the Nepal Valley in mid-April, where Proud (1955, p. 69) noted it as common between *c.* 1525 and 2135 m. in April.

My female specimen still has traces of chestnut bars on the head and nape.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	155, 155.5	130, 132	24, —
1 ♀ :	149	128	23.5

In listing Hodgson's collection of cuckoos, Gray & Gray (1846, pp. 119-120) and Gray (1863, p. 65) made a curious mixture of *C. micropterus, C. saturatus,* and *C. poliocephalus.* However, from a reference to Shelley (1891, pp. 243-244, 254, 257) we find that Hodgson presented 5 specimens of *C. micropterus,* 11 of *C. saturatus,* and 6 of *C. poliocephalus* to the British Museum.

237. **Cuculus sonnerati sonnerati** Latham. Indian Banded Bay Cuckoo.

DUN : Hitaura : 1 ♂ (May 26).

We came across the Banded Bay Cuckoo in Nepal once, when the specimen was collected.

Gray & Gray (1846) and Gray (1863) did not mention any specimen of this species in the Hodgson collection, but Shelley (1891, p. 264) listed two examples presented by Hodgson. This cuckoo was not reported from Nepal by Scully (1879), Ripley (1950b) or Rand & Fleming (1957).

Measurements : 1 ♂ : Wing 118 ; tail 114+; bill 25.

238. **Cuculus passerinus** Vahl. Indian Plaintive Cuckoo.

MARKHU VALLEY : Kulikhani : 1 ♂ (April 27). CHITLANG VALLEY : Chitlang: 2 ♂♂ (July 2).

The Indian Plaintive Cuckoo is scarce in Nepal. It occurs near villages between the Mahabharat and Chandragiri ranges.

After Hodgson's collection, ours appears to be the only record of this species from Nepal.

The Chitlang specimens had remains of caterpillars in their stomachs.

Measurements : 3 ♂♂ : Wing 116, 118, 120 ; tail 113, 114, 115 ; bill 22, 23 (2).

Biswas (1951b) has shown that the greybellied *C. passerinus* and the rufousbellied *C. querulus* should be treated as distinct species.

*239. **Chrysococcyx maculatus** (Gmelin). Emerald Cuckoo.

The only post-Hodgsonian record of the Emerald Cuckoo from Nepal is Proud's (1955, p. 69), who once saw a small party in Kathmandu, Nepal Valley, on September 7.

240. **Surniculus lugubris dicruroïdes** (Hodgson). Indian Drongo-Cuckoo.

Dun : Hitaura, Paharé Ghat, Bhimphedi : 8 ♂♂, 4 ♀♀ (May 5-26, June 1-19, July 20). Nepal Valley : Godavari, Thankot : 4 ♂♂ (April 13, May 10-20).

The Drongo-Cuckoo is a common bird in the wooded parts of the Nepal Valley, the bases of the hills surrounding it, and in the duns. It is usually found in the clearings and edges of forests.

Scully (1879) did not report it from Nepal, and Rand & Fleming (1957, p. 75) found it only in the lowlands.

The July specimen had caterpillars in its stomach.

The April specimens had non-breeding gonads. By May swelling of the gonads had already commenced (right testes measured 3.75-5×2-3 mm. and the left, 5-6×3-4), and in June the birds were in breeding condition. A male on June 14 had 10×6 (right) and 12×7.5 (left) mm. testes ; a female on June 11 had a 10 mm. ovum, and another female was laying on June 19,—it had an oviducal egg heavily spotted purplish around ends.

Colours of soft parts : Iris dark brown (once reddish brown) ; bill black ; legs and feet bluish slaty ; claws horny ; pads white.

Measurements :

	12 ♂♂	4 ♀♀
Wing :	138 (2), 141, 142 (2), 144, 144+, 145, 145.5, 146, 147, 148	139+, 143.5, 144, 145.5
Tail :	130+, 132, 133, 137, 138, 139 (2), 140, 141, 142,— (2)	128, — (3)
Bill :	24, 25 (2), 25.5, 26 (4), 26.5 (2), — (2)	25, 26 (2), —

[cf. tail length ♂♀ : 106-133, according to Baker (1927, p. 165).]

241. **Eudynamys scolopacea scolopacea** (Linnaeus). Indian Koel.

Nepal Valley : Pashupatinath, Thankot : 3 ♂♂, 2 ♀♀ (March 30, April 14, 28, May 20).

The Koel is common about villages of the Nepal Valley during spring and summer. It is, however, not found on the hills surrounding the Valley. Biswas (1960a) reported it from the Arun watershed, eastern Nepal, at *c.* 915-1525 m. in June.

One of my male specimens (May 20, breeding) has all the primary coverts and the outermost primary tipped white, and the four outermost secondaries narrowly fringed with white. An examination of adult male specimens available to me from all over India shows that white is present in about 13.5 per cent specimens in varying degrees on all or some wing coverts, wing feathers, upper tail coverts, tail feathers, and even feathers of the neck, breast and abdomen, the tips of rectrices frequently being very pale rufous instead of white. The birds with white-tipped feathers have all been taken in the months of February, May, September, October, and November. Reference to available literature does not give me any idea of the significance of these spots.

On April 28 a female specimen had quite a large ovary, measuring 23×25, with the largest ova 13 and 11 mm., while a male taken May 20, had a 10.5×7.5 mm. right testis.

Colours of soft parts : Iris crimson ; bill greenish horny but without greenish on the base, around nostrils and tip of upper mandible (in one specimen, however, it was dark horny on the basal half, horny on culmen and greenish horny on the anterior half) ; legs and feet plumbeous ; claws dark horny ; pads white.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	199, 202, 205	186, 189, 205	32 (2), 33.5
2 ♀♀ :	188, 192	181+, 189	32.5, 33

242. **Taccocua tristis tristis** (Lesson). Himalayan Greenbilled Malkoha.

TARAI : Simra : 1 ♀ (March 5). BHABAR : Amlekhganj : 3 ♀♀ (March 9, 10). DUN : Hitaura, Paharé Ghat, Bhimphedi : 4 ♂♂, 1 juv. ♂, 1 fledgling ♂, 6 ♀♀ (March 13, May 8—June 20, July 12). NEPAL VALLEY : Thankot : 1 ♂, 1 ♀ (April 8, 9).

The Greenbilled Malkoha is relatively a rare bird in the Nepal Valley, but in the bhabar and dun of central Nepal, it is very common in the forests, both in the dense parts and in the thorny bushes.

The coloration of the fledgling male (June 1) is similar to that of adult, birds. The tail is proportionately very small. The juvenile male (July 12) has the tail about half-grown.

A female was laying on May 24, while another on June 10 had the ovary not fully enlarged, its largest ovum being only 5 mm. Likewise a male on June 12 had the testes measuring only 6×3.5 (right) and 7×4 (left) mm.

Many of the specimens are worn, some very much so. Two female specimens (March 9 and June 10) have the central rectrices still growing, while other rectrices are fresh. Another female (June 12) has the rectrices and under tail coverts in moult. Tail moult in this species is found to be centripetal.

Colours of soft parts : ADULT : Iris brown (once crimson); orbital skin deep crimson; bill dark green with red on the base and around nostrils (once paler green on anterior two-thirds); legs and feet greenish slaty (once without green on feet); claws horny; pads white.

FLEDGLING : Iris brown, orbital skin dark brown ; upper mandible slaty horny ; lower mandible greenish horny ; legs and feet pale plumbeous ; claws dark horny ; pads white.

Measurements :

	5 ♂♂	11 ♀♀
Wing :	168, 168+, 170 (2), 171	164, —, 167+ (2), 169, 170 (2), 170+, 171, 172+, 173
Tail :	— (4), 385	— (6), 345, 390, 404, 405+, 415
Bill :	36 (2), 36.5 (2), 37	36 (5), 36.5, 37 (5

243. **Taccocua leschenaulti infuscata** Blyth. Hill Sirkeer Cuckoo.

Bhabar : Amlekhganj : 1 ♂ (March 7). Dun : Hitaura : 1 ♂, 1 ♀ (May 19).

The Sirkeer Cuckoo did not appear to us as a common bird in Nepal. It has not so far been reported from the Valley, but we came across it a few times in the central bhabar and dun, usually in scrub jungles.

The female specimen (May 19) had an enlarged ovary with the largest ovum about 6 mm. in diameter.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	156, 157	—, 226	33 (2)
1 ♀ :	158	230+	34

244. **Centropus sinensis sinensis** (Stephens). Common Crow-Pheasant.

Dun : Hitaura : 4 ♂♂, 1 juv. ♂, 1 ♀ (May 23, June 12-19).

During May and June the characteristic resonant call of the Crow-Pheasant is frequently heard in the central dun, but due to the presence of very thick undergrowth and its skulking habits, it is not so commonly seen.

Ours appears to be the only post-Hodgsonian record of this species from Nepal.

The juvenile male specimen (June 19) corresponds very closely to Baker's (1927, p. 190) description of young birds, except that my specimen has the vent downy.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	193, 200, 208, 210	222+, 246, —, 254	38, 39.5, 40, 41
1 ♀ :	207	232 +	39

A comparison of the measurements of correctly sexed specimens from northern India and southern China with those from southern Assam, Burma, Siam, and Indo-China, reveals that individual variation in size is indeed very great in each population, so that Hume's *intermedius* from 'Dhoon [=Dehra Dun], Dacca and Thayetmyo' can hardly be recognized.

245. **Centropus toulou bengalensis** (Gmelin). Lesser Crow-Pheasant.

Dun : Hitaura : 5 ♂♂, 5♀♀ (May 30, June 13-20, July 28).

The Lesser Crow-Pheasant is not uncommon in the central dun. It occurs in grass and scrub forests.

I am unable to find any record save ours for this species from Nepal since Hodgson's days.

One of the testes of a July specimen measured 14 mm. long.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	137+, 141, 143, 144, 148	163, 165, 181+, — (2)	25, 26, 27 (2), —
5 ♀♀ :	161+, 163+, 164, 166+, 169	180+, 200, — (3)	28, 29, 29.5, 30.5, —

(*To be continued*)

Revision of Indian Spiders of the genus *Cyrtarachne* (Argiopidae : Arachnida)

BY

B. K. Tikader

(*With five text-figures*)

INTRODUCTION

The Oriental spiders of the genus *Cyrtarachne* were first described by Thorell (1895). Pocock (1900) recorded two known species of the genus and described one new species.

Two known and three new species in the collections of the Zoological Survey of India are described in this paper.

Family ARGIOPIDAE

Genus **Cyrtarachne** Thorell

(Type: *Cyrtogaster grubei* Keyserling, 1864)

1868. *Cyrtarachne,* Thorell, EUG. RESA. ZOOL. ARACH. p. 10.
1895. *Cyrtarachne,* Simon, HIST. NAT. ARAIGN. 1, p. 880.
1895. *Cyrtarachne* Thorell, SPIDERS OF BURMA, p. 201.
1900. *Cyrtarachne,* Pocock, FAUNA OF BRITISH INDIA, ARACHNIDA p. 228.

This genus was erected by Thorell to include *Cyrtogaster grubei* Keyserling, 1864. The name *Cyrtogaster* being preoccupied in Keyserling, Thorell proposed *Cyrtarachne* in the year 1868. He has given a detailed diagnosis in his book SPIDERS OF BURMA.

Characters. Carapace unarmed, convex, median eyes not very prominent, the ocular quadrangle generally slightly wider than long, laterals contiguous. Abdomen large, wider than long, integument leathery, strongly overlapping the posterior region of cephalothorax in front. Chelicerae subapically with outer row of large teeth, which differ in size and inner row of variable number of smaller teeth.

Distribution. Mediterranean, Ethiopian, Oriental, and Australian Regions.

KEY TO INDIAN SPECIES

1. Abdomen pointed behind .. .. 2.
Abdomen not pointed behind .. .. 3.
2. Abdomen with black patch below, vulva triangular .. .. .. *C. inaequalis*
Abdomen with no black patch below, vulva with a short narrow tubercle .. .. *C. raniceps*
3. Abdomen chocolate colour, with white patch antero-laterally, vulva kidney-shaped .. *C. bengalensis* sp. nov.
Abdomen yellowish with all sigilla encircled by black patch, vulva almost rounded at the base provided with two blunt tubercles .. *C. gravelyi* sp. nov.
Abdomen light yellowish grey, armed above with symmetrically placed tooth-like tubercles. Vulva rounded at the base but apically triangular .. *C. biswamoyi* sp. nov.

LIST OF SPECIES

Cyrtarachne inaequalis Thorell

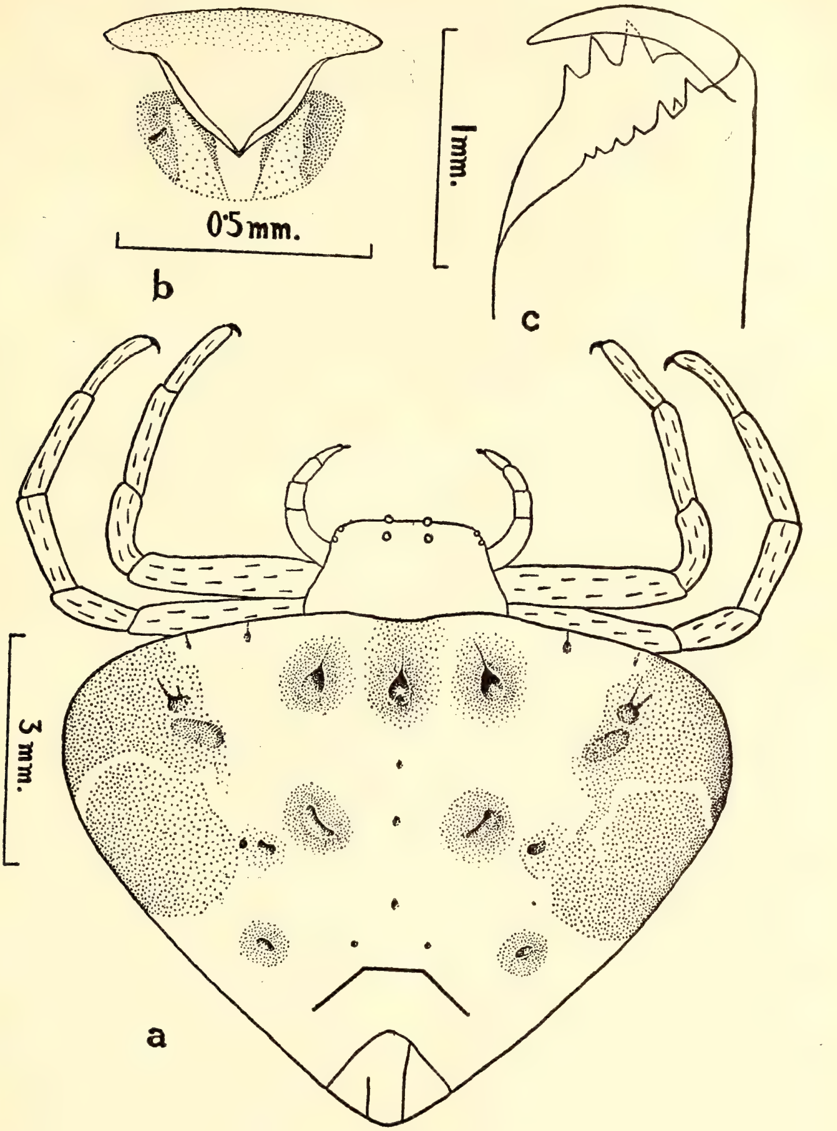
1895. *Cyrtarachne inaequalis* Thorell, SPIDERS OF BURMA, London. p. 201. (Type-locality : Tounghoo, Burma.)
1900. *Cyrtarachne inaequalis*, Pocock, FAUNA OF BRITISH INDIA, ARACHNIDA p. 229.

Material. 2♀♀, from Botanical Garden, Sibpur, Dist. Howrah, West Bengal. Coll. B. K. Tikader, 11-11-1956; 2♀♀, from Muki, Dist. Balaghat, Madhya Pradesh. Coll. B. K. Tikader, 9-10-1957.

General. Cephalothorax ochre-yellow, abdomen yellowish, legs brownish. Total length 10.50 mm.; carapace 3.50 mm. long, 3.20 mm. wide; abdomen 9.10 mm. long, 11.00 mm. wide.

Cephalothorax. Relatively broader in front, slightly longer than wide. The area of four median eyes slightly elevated. Clypeus narrow. Chelicerae subapically with outer row of 3 large teeth and inner row first and third teeth large and rest smaller. Text-fig. 1, c. Sternum heart-shaped. Legs stout, clothed with hairs.

Abdomen. Triangular, strongly overlapping the posterior region of cephalothorax in front; wider than long, anterior lateral surface bulging out into a smooth conical prominence and furnished with a dark brown patch. Ventral surface of the abdomen black behind the epigastric fold. Epigyne triangular at the base but apically pointed. Text-fig. 1, b.



Text-fig. 1. *Cyrtarachne inaequalis* Thorell
(a) Dorsal view of whole body; (b) Epigyne; (c) Chelicera

Distribution. Burma: Tounghoo and Tharrawaddy.
India: West Bengal; Balaghat Dist., Madhya Pradesh.

Cyrtarachne raniceps Pocock

1900. *Cyrtarachne raniceps* Pocock, FAUNA OF BRITISH INDIA, ARACHNIDA p. 229. (Type-locality : Ceylon.)

Material. 1 ♀, with cocoon from Habra *c.* 48 kilometres north-east of Calcutta, West Bengal. Coll. B. K. Tikader, 7-9-1958.

General. Cephalothorax and abdomen ochre-yellowish brown, legs greenish. Total length 9.30 mm.; carapace 2.50 mm. long, 2.00 mm. wide; abdomen 9.00 mm. long, 11.70 mm. wide.

Cephalothorax. Relatively broader in front, slightly longer than wide. Median eyes more or less equal in size and laterals slightly smaller than medians; ocular quad as long as wide. Clypeus narrow. Chelicerae subapically with outer row of 3 large teeth and inner row first tooth large and rest smaller. Text-fig. 2, c. Sternum heart-shaped. Legs stout, clothed with hairs.

Abdomen. Wider than long, triangular, strongly overlapping the posterior region of cephalothorax in front; broadest in its anterior half, where it bulges out laterally into a large smooth conical prominence, the lateral prominences amber or deep brown at the tip, partially surrounded at the base by dark brown and pale lines. Ventral side of abdomen more yellowish than dorsal. Epigyne with scape in the form of a short narrow tubercle. Text-fig. 2, b.

Distribution. Ceylon.
India: West Bengal.

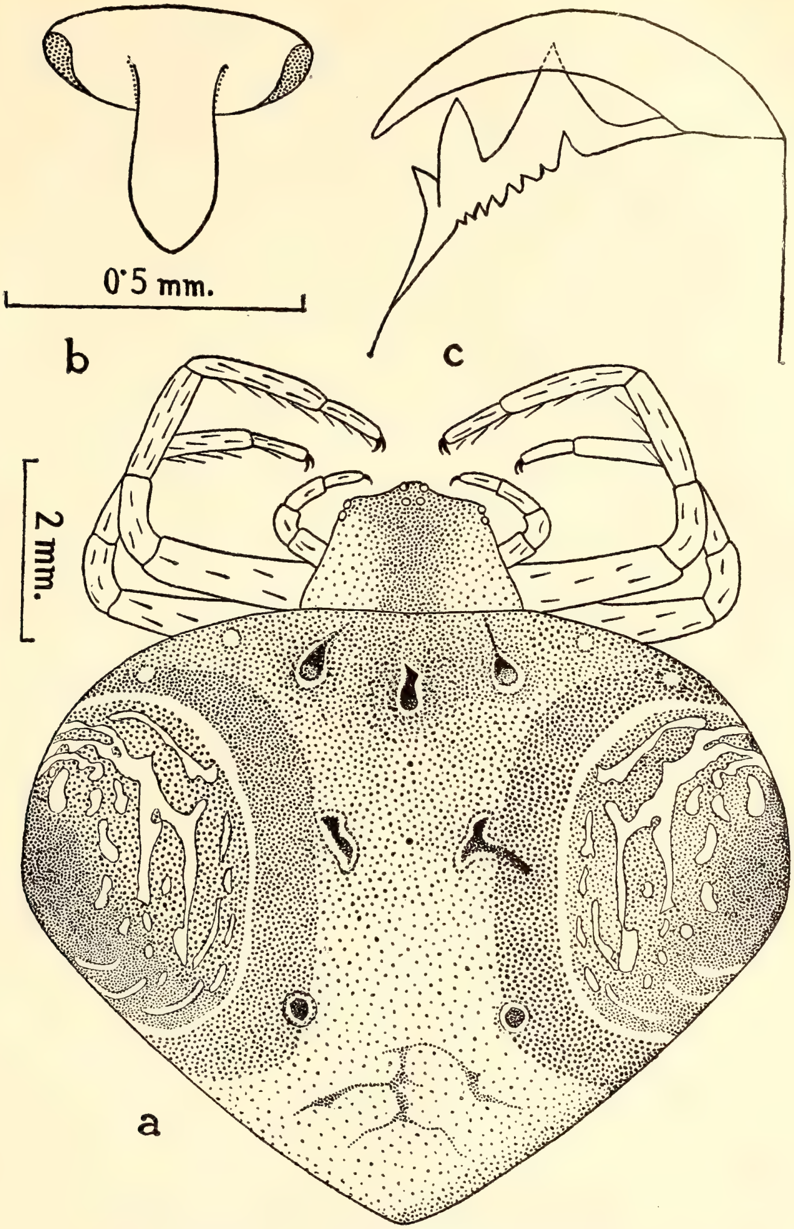
Cyrtarachne bengalensis sp. nov.

Material. 2♀♀, from Botanical Garden, Sibpur, Dist. Howrah, West Bengal. Coll. B. K. Tikader, 11-11-1956.

General. Cephalothorax and legs chocolate in colour, abdomen slightly paler than cephalothorax. Total length 7.20 mm.; carapace 2.00 mm. long, 1.20 mm. wide; abdomen 6.00 mm. long, 8.00 mm. wide.

Cephalothorax. Relatively broader in front, slightly longer than wide. Ocular quad square, lateral eyes slightly smaller than medians. Clypeus narrow. Chelicerae subapically with outer row of three large teeth and inner row of three small teeth. Text-fig. 3, c. Sternum heart-shaped, pointed behind. Legs short, clothed with hairs.

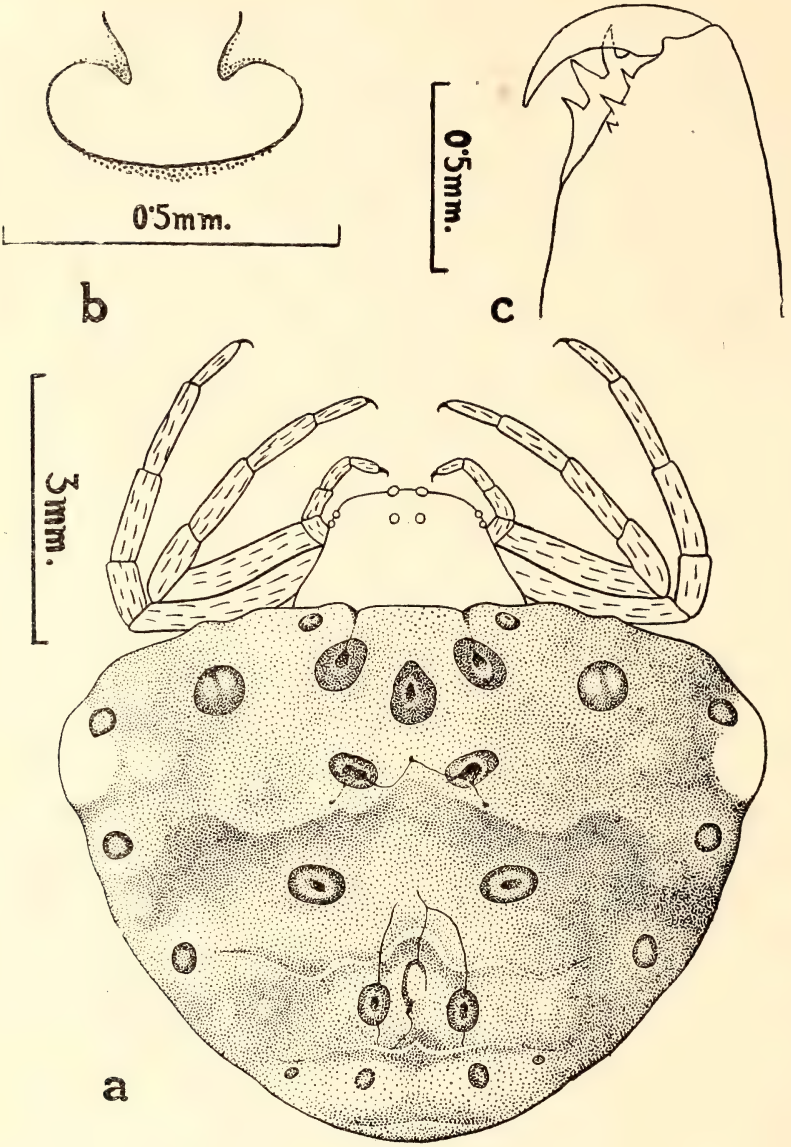
Abdomen. Moderately rounded posteriorly, strongly overlapping the posterior region of cephalothorax in front, wider than long, anterior lateral surface slightly bulging out into a smooth prominence and furnished with a white patch. Epigyne broad elongated at the base but apically kidney-shaped. Text-fig. 3, b.



Text-fig. 2. *Cyrtarachne raniceps* Pocock
(a) Dorsal view of whole body; (b) Epigyne; (c) Chelicera

Holotype. One female in spirit in the National Zoological Collections, Zoological Survey of India, Calcutta.

This species resembles *Cyrtarachne cingulata* Thorell, but is



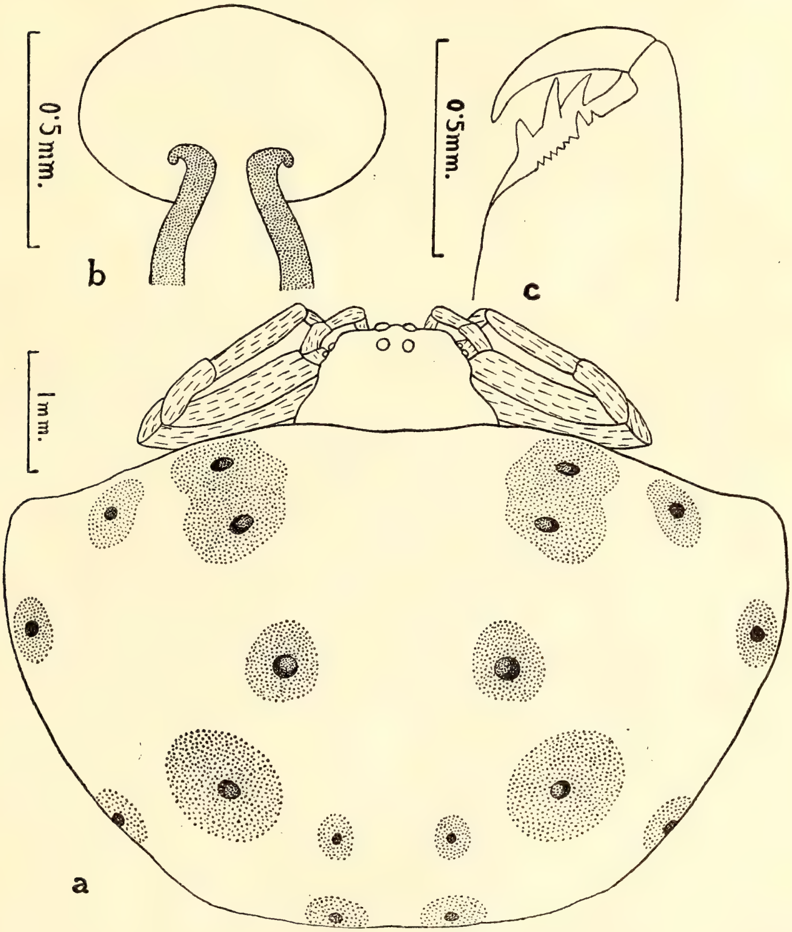
Text-fig. 3. *Cyrtarachne bengalensis* sp. nov.
(a) Dorsal view of whole body; (b) Epigyne; (c) Chelicera

separated as follows: (i) Abdomen pale chocolate-coloured, moderately rounded posteriorly and anterior lateral extremities with a white patch but in *C. cingulata* abdomen black, widely rounded posteriorly and with a broad yellow ring narrowly interrupted below round its lateral extremities.

Cyrtarachne gravelyi sp. nov.

Material. 1♀, from Pashok, Darjeeling District, West Bengal. Coll. F. H. Gravely, 26-5-1916.

General. Cephalothorax and legs light yellowish, abdomen ochre-yellow. Total length 6.00 mm.; carapace 1.60 mm. long, 1.50 mm. wide; abdomen 5.00 mm. long, 7.30 mm. wide.



Text-fig. 4. *Cyrtarachne gravelyi* sp. nov.
(a) Dorsal view of whole body; (b) Epigyne; (c) Chelicera

Cephalothorax. Relatively broader in front, slightly longer than wide. Cephalic region high, median eyes more or less equal in size and ocular quad as long as wide, lateral eyes small and contiguous. Chelicerae subapically with outer row of three large teeth and inner row first two teeth large and rest smaller. Text-fig. 4, c. Clypeus narrow. Sternum heart-shaped. Legs short and stout, clothed with hairs.

Abdomen. Large, nearly twice as broad as long, widely rounded posteriorly; strongly overlapping the posterior region of cephalothorax in front. All sigilla encircled by black patches. Ventral surface of abdomen deep brown behind the epigastric fold. Epigyne more or less rounded at the base provided with two blunt tubercles. Text-fig. 4, b.

Holotype. One female in spirit in the National Zoological Collections, Zoological Survey of India, Calcutta.

This species is closely related to *C. cingulata* Thorell, but differs as follows: (i) Abdomen ochre-yellow, all sigilla encircled by black patches but in *C. cingulata* abdomen black, all sigilla encircled by white patches and with a broad yellow ring narrowly interrupted below round its lateral extremities.

Cyrtarachne biswamoyi sp. nov.[1]

Material. 6♀♀, from Muki, District Balaghat, Madhya Pradesh. Coll. B. K. Tikader, 9-10-1957.

General. Cephalothorax and legs yellowish, abdomen light yellowish grey. Total length 6.20 mm.; carapace 2.60 mm. long, 2.00 mm. wide; abdomen 5.00 mm. long, 8.90 mm. wide.

Cephalothorax. Relatively broad in front, slightly longer than wide, scantily clothed with hairs. Median eyes more or less equal in size and ocular quad slightly longer than wide, laterals small and contiguous. Chelicerae subapically with outer row of three large teeth and inner row two median teeth. Text-fig. 5, c. Clypeus narrow. Sternum heart-shaped. Legs short and stout, clothed with hairs.

Abdomen. Large, armed above with a few symmetrically placed tooth-like tubercles, nearly twice as broad as long, widely rounded posteriorly; strongly overlapping the posterior region of cephalothorax in front. Almost all sigilla yellow in centre and encircled by black patch. Epigyne more or less rounded at the base but apically triangular. Text-fig. 5, b.

Holotype. One female in spirit in the National Zoological Collections, Zoological Survey of India, Calcutta.

This species is closely related to *C. cingulata* Thorell, but differs

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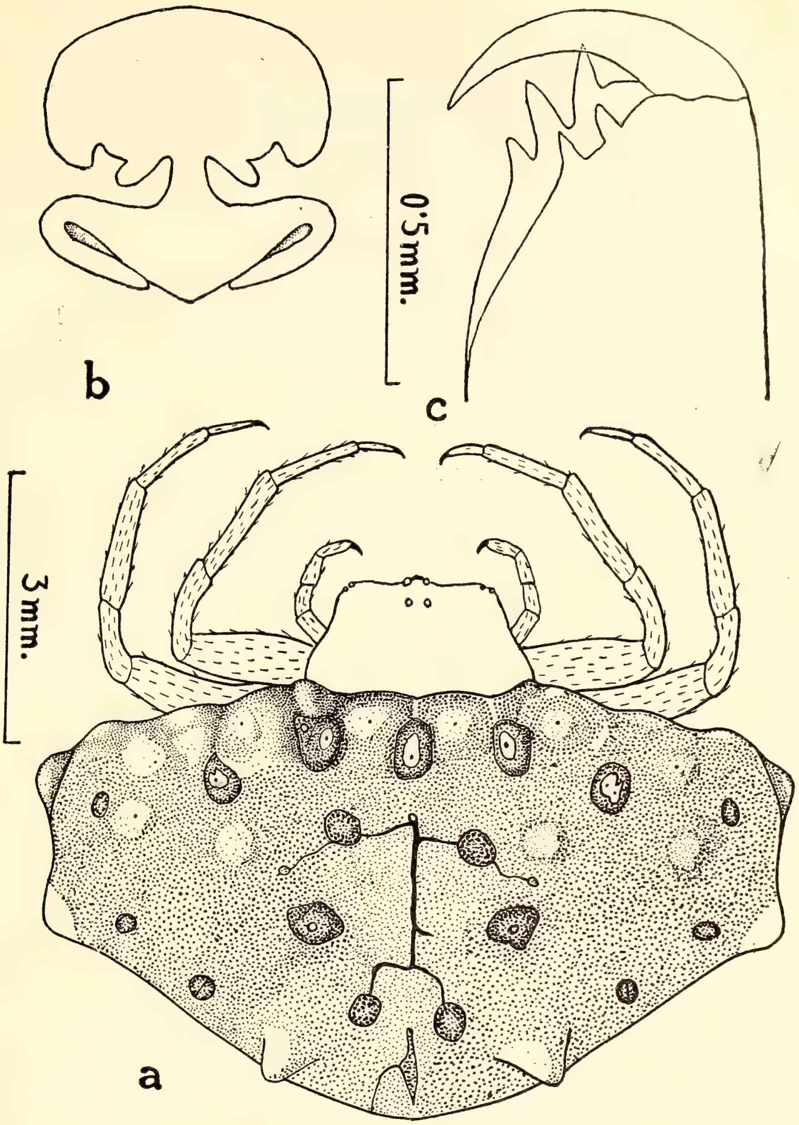
[1] I have pleasure in naming this after Dr. Biswamoy Biswas, Ornithologist, Zoological Survey of India, Calcutta.



Text-fig. 5. *Cyrtarachne biswamoyi* sp. nov.
(a) Dorsal view of whole body; (b) Epigyne; (c) Chelicera

as follows: (i) Abdomen light yellowish grey, sigilla yellow in centre and encircled by black patch but in *C. cingulata* abdomen black, sigilla black in centre and encircled by white patch. (ii) Abdomen armed above with a few symmetrically placed tooth-like tubercles but in *C. cingulata* abdomen rounded and smooth.

SUMMARY

Three new and two known species of Indian spiders of the genus *Cyrtarachne*, family Argiopidae are described in this paper. All species were collected from West Bengal and Madhya Pradesh, India. All the type specimens are in the Zoological Survey of India, Calcutta.

ACKNOWLEDGEMENTS

I am grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for facilities. My thanks are also due to Dr. M. S. Mani, Deputy Director, for guidance and going through the manuscript.

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Thysanoptera from the Nilgiri and Kodaikanal Hills (South India)

BY

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(*With six figures*)

The Nilgiri and Kodaikanal hill ranges of south India constitute a favourable collecting ground for Thysanoptera in view of their rich vegetation, both natural and introduced. Aid given by the Sir Dorabji Tata Memorial Trust through the Bombay Natural History Society enabled the author to make a survey of the Thysanoptera of this area, the results of which form the basis of this paper. Apart from the discovery of a new genus *Aroidothrips*, some of the rarer genera as *Bolacothrips* Priesner, *Apterygothrips* Priesner, and *Stictothrips* Hood were recorded, their corresponding species being new. In addition, *Ramaswamiahiella kallarensis* sp. nov. and *Dolichothrips* (*Dolicholepta*) *rambhutanae* sp. nov. are described and records new to the Indian region, such as *Haplothrips euphorbiae* Priesner and *Sericothrips occipitalis* Hood, are included.

Several species of horticultural importance causing severe damage to the flowers of such plants as carnations, gladiolus, orchids, iris, asters, hollyhocks, and a host of others listed below, mostly introduced into our mainland and thriving generally at high altitudes in extensive and well-maintained gardens, have been recorded during the course of the present study. The role played by thrips in causing serious economic losses to horticulturists is a recognised fact abroad, but no record exists in India of the intensity of thrips infestation on ornamental plants. Besides the presence of casual visitors and others of minor importance as pests, the following species deserve special mention as proving destructive to flowers or having sufficient potentialities of becoming serious pests : *Thrips tabaci* Lindeman on carnations, *Thrips florum* Schmutz, *Thrips melaneurus* Bagnall, and *Thrips palmi* Karny on different species of roses, *Thrips nilgiriensis* Ramakrishna on orchids, *Taeniothrips simplex* Morrison on gladiolus, *Haplothrips gowdeyii* (Franklin) and *Trybomiella ramakrishnai* Karny on hollyhocks, canna, etc. No information is available on thrips infesting glass houses in India ; attempts to collect them from the few glass houses at Ootacamund proved futile, the only species obtained being *Heliothrips haemorrhoidalis* (Bouche) from flowers of begonia.

LIST OF SPECIES RECORDED

Suborder Terebrantia Haliday

Sericothrips graminis Ananthakrishnan
Sericothrips occipitalis Hood
Aptinothrips rufus (Gmelin)
Scirtothrips dorsalis Hood
Anaphothrips (*Neophysopus*) *flavicinctus* (Karny)
Exothrips madrasensis Ananthakrishnan
Ramakrishnothrips jonnaphila (Ramakrishna)
Ramakrishnothrips cardamomi (Ramakrishna)
Frankliniella sulphurea Schmutz
Taeniothrips distalis Karny
Taeniothrips simplex (Morrison)
Aroidothrips longistylus gen. et sp. nov.
Bolacothrips bicolor sp. nov.
Ramaswamiahiella kallarensis sp. nov.
Thrips florum Schmutz
Thrips tabaci Lindeman
Thrips parvus Schmutz
Thrips apicatus Priesner
Thrips nilgiriensis Ramakrishna
Thrips bambusae Shumsher
Thrips melaneurus Bagnall
Thrips palmi Karny
Heliothrips haemorrhoidalis Bouche
Helionothrips kadaliphila (Ramk. & Marg.)
Caliothrips indicus (Bagnall)

Suborder Tubulifera Haliday

Stictothrips fimbriata (Ananthakrishnan)
Hoplothrips indicus sp. nov.
Bamboosiella bicoloripes Ananthakrishnan
Haplothrips (*Trybomiella*) *ramakrishnai* Karny
Haplothrips gowdeyii (Franklin)
Haplothrips euphorbiae Priesner
Xylaplothrips pictipes Bagnall
Dolichothrips (*Dolicholepta*) *rambhutanae* sp. nov.
Praepodothrips indicus Priesner & Seshadri
Praepodothrips priesneri Ananthakrishnan

Praepodothrips cymbopogoni Ananthakrishnan
Apterygothrips pini sp. nov.
Gynaikothrips karnyi Bagnall
Gynaikothrips interlocatus Karny
Cercothrips tibialis Zimmerman

Sericothrips graminis Ananthakrishnan

1956. *Sericothrips graminis* Ananthakrishnan, T. N. *in* Zool. Anz. **156** : 31-33.

NILGIRIS : Coonoor, Sims Park 5500′, 2 females on grass, 10-5-1959.

A typical grass inhabiting bicolorous species with abdominal segments I-V yellow and VI-X dark grey-brown. Longitudinal vein of forewing with 24 bristles.

Sericothrips occipitalis Hood

1917. *Sericothrips occipitalis* Hood, J. D. *in* Bull. Brook. Ent. Soc. **12** (2) : 32-34.

NILGIRIS : Burliar Fruit Research Station 2500′, 8 females and 4 males on leaves of *Pueraria phaseoloides*, 8-5-1959.

This species is a new record to India and is allied to *S. graminis* Ananthakrishnan, with 3 abdominal segments predominantly yellow. Foreangles of pronotum produced acutely and reticulations on occiput and pronotal area outside plate, distinctly net-like.

Aptinothrips rufus (Gmelin)

1788. *Thrips rufa* Gmelin, Caroli Linn. Syst. Nat. : 2224.

1836. *Aptinothrips rufa* Haliday, A. H. *in* Ent. Mag. **3**.

1902. *Aptinothrips rufa* Hinds, H. E. *in* Proc. U.S. Nat. Mus. **26**.

1935*a*. *Aptinothrips rufus* Speyer, E. R. *in* Trans. R. Ent. Soc. Lond. **8** : 483-508.

NILGIRIS : Pomological Station, Coonoor 5500′, 6 females on grass, 10-5-1959.

Though this is a typical grass-infesting form common throughout Europe, U.S.A., Egypt, Chile, etc., it has not so far been recorded from India on grasses as far as the available literature shows. However, *Aptinothrips rufus* var. *connaticornis* Bagnall has been recorded from Darjeeling in tea flowers.

Scirtothrips dorsalis Hood

1919. *Scirtothrips dorsalis* Hood, J. D. *in* Insec. Inscit. Menstr. **7** : 90-91.

1932. *Scirtothrips dorsalis* Ramakrishna, T. V. *in* Agr. Livestk. Ind. **2** (4) : 393-394.

NILGIRIS : Kallar Fruit Research Station 1500′, 6 females on flowers of wood apple, 8-5-1959.

Anaphothrips (Neophysopus) flavicinctus (Karny)

1912. *Euthrips flavicinctus* Karny, H. H. *in* Marcellia **11** : 115.

1913. *Neophysopus medioflavus* Schmutz *in* Sitz. Akad. Wiss. Wien. **112** : 1017.

1919. *Euthrips citricinctus* Bagnall, R. S. *in* A. M. N. H. (9) **4** : 270.

1925. *Anaphothrips flavicinctus* Karny, H. H. *in* Ark. Zool. **17** : 17.

1928. *Anaphothrips* (*Euthrips*) *citricinctus* Ramakrishna, T. V. *in* Mem. Dept. Agr. Ind., Ent. ser., (7) **10** : 269.

NILGIRIS : Coonoor Pomological Station 5500′, numerous females on grass, 10-5-1959. KODAIKANAL : Shembaganur, Sacred Heart College 5000′, numerous females on grass, 5-6-1959.

One of the commonest species of grass-inhabiting thrips, this species exhibits alary polymorphism, with macropterous, brachypterous, and apterous individuals. Only 4 brachypterous and 2 apterous females were collected, the rest being macropterous.

Exothrips madrasensis Ananthakrishnan

1956. *Exothrips madrasensis* Ananthakrishnan, T. N. *in* Zool. Anz. **157** : 130-132.

NILGIRIS : Coonoor Pomological Station 5500′, 2 females on grass, 10-5-1959.

Ramakrishnothrips jonnaphila (Ramakrishna)

1928. *Taeniothrips jonnaphila* Ramakrishna *in* Mem. Dep. Agri. Ind., Ent. ser., (7) **10** : 256-258.

1940. *Physothrips jonnaphila* Ramakrishna, Cat. Ind. Insects, pt. 25 : 21.

1942. *Ramakrishnothrips jonnaphila* Shumsher *in* Indian J. Ent. **4** (2) : 6-7.

1945. *Ramakrishnothrips jonnaphila* Shumsher, ibid. **7** : 154.

Kodaikanal : Perumalmalai Hills 5500′, numerous males and females on leaf-sheaths of *Sorghum* and wild cane, 5-5-1959.

The above species is distinguished from *R. cardamomi* (Ramakrishna) by the absence of a comb on the VIII abdominal segment, costa of forewing with 24-28 bristles and lower vein with 13-14 bristles.

Ramakrishnothrips cardamomi (Ramakrishna)

1935. *Taeniothrips cardamomi* Ramakrishna *in* Bull. Ent. Res. **26**: 35-38.

1942. *Ramakrishnothrips cardamomi* Shumsher *in* Indian J. Ent. **4** (2) : 6-7.

1945. *Ramakrishnothrips cardamomi* Shumsher, ibid. **7** : 154.

Nilgiris : Burliar Fruit Research Station 2500′, numerous males and females on leaf-sheaths and leaves of cardamom, 8-5-1959. Kodaikanal : Numerous males and females inside leaf-sheaths of Cannaceae, Bryant's Park, 4-6-1959.

This species is characterised by the presence of a comb on the VIII abdominal segment, costa of forewing with 14 or 15 bristles and lower vein with 5 bristles.

Frankliniella sulphurea Schmutz

1913. *Frankliniella sulphurea* Schmutz *in* Sitz. Akad. Wiss. Wien. **112** : 1019.

Kodaikanal : Bryant's Park 6500′, numerous females on *Chrysanthemum* flowers and flowers of *Hibiscus*, 4-6-1959.

This is one of the commonest flower-infesting thrips having a very wide distribution and extremely polyphagous habit.

Taeniothrips distalis Karny

1913. *Taeniothrips distalis* Karny, H. H. *in* Archiv. F. Naturgeschichte: 122.

1916. *Taeniothrips distalis* Bagnall, R. S. *in* A. M. N. H. (8) **17**: 218.

Nilgiris : Ootacamund, Raj Bhavan Gardens 7000′, 2 females on Papilionaceous flowers, 11-5-1959.

Taeniothrips simplex (Morrison)

1930. *Physothrips simplex* Morrison, G. D. *in* Bull. Ent. Res. **21** (1) : 12-13.

1938. *Taeniothrips simplex* Bailey, S. F. *in* Univ. Calif. Col. Agri. Expt. Sta. **346** : 50-52.

NILGIRIS : Raj Bhavan Gardens 7000′, several females on *Gladiolus* flowers and leaves, 11-5-1959. KODAIKANAL : Shembaganur, Sacred Heart College Gardens 5000′, numerous females on *Gladiolus* flowers and leaves; Mt. St. Mary's 7500′, numerous females on *Gladiolus* flowers, 5-6-1959.

The *Gladiolus* thrips is a cosmopolitan form known from widely separated countries of the world and presumably introduced into India with corms, in view of their ability to reproduce on their surface. Unlike *Thrips tabaci*, this has a very limited host range and of the several plants examined its presence was recorded only from *Gladiolus* primarily and on carnations and iris occasionally. That this is assuming major pest proportions is evident from the fact that in several *Gladiolus* plants badly damaged flower buds were observed which failed to open. In the otherwise red or purple petals of the flowers, bleached areas or irregular silvery patches appeared due to the feeding of the adults and larvae in considerable numbers.

Genus **AROIDOTHRIPS** gen. nov.

Body slender. Head wider than long, transversely reticulate at base ; eyes large, occupying $\frac{3}{4}$ head length. Antenna 8-jointed, long and thin, 3.7 times head length ; joint 2 of style $2\frac{1}{2}$ to 3 times as long as joint 1 ; sense cones on 3 and 4 forked, long and stout ; antennal joints densely setose. Mouth cone short and blunt, maxillary palp 3-jointed. Prothoracic bristles very well developed, outer postangulars much longer than inner ; anteroangulars shorter than anteromarginals. Wings present, normal ; bristles and veins well developed, the lower vein with a continuous series. Lateral portions of abdominal tergites without net sculpture. Apex of abdomen not tubiform or unusually narrowed.

This new genus is closely allied to *Ayyaria* Karny and *Diarthrothrips* Williams but differs from them in the 3-jointed maxillary palpi, the nature of the antennal style and the sense cones.

Aroidothrips longistylus sp. nov.

Macropterous female :

General colour yellow with plenty of grey areas. Antennal joints uniform grey, sense cones pale. Head and thorax yellowish grey ; pterothorax dark yellow mesad, greyish yellow at sides ; abdominal segments II-VIII at anterior margins with bands of light grey pigments and with little red pigment mesad ; anterior and posterior borders of prothorax with red pigment. Forewings uniform grey-brown ; bristles not hyaline, dark.

Head wider than long, 147 μ across eyes, 126 μ at base and 105μ long (Fig. 1A). Eyes large, 70 μ long and equally wide. Cheeks with weak setae and head at base with transverse striae. Antenna very characteristic (Fig. 1a), 3.7 times head length, with a long, fine style, the terminal joint of which is 2½ to 3 times as long as joint 1 ; joint 4 long and bottle-like ; sense cones on 3 and 4 forked, long and stout, that on 3, 54 μ long and 22 μ between arms, that on 4, 64 μ long and 18 μ between arms ; antennal joints : length (width) in μ : 26-32 (29), 35-38 (29), 61 (26-29), 87-90 (26), 55-58 (19), 58-67 (18), 10 (6), 25-29 (4) ; setae on antennal joints very well developed, long and pointed, measuring 48-58 μ long and disposed as in the figure. Mouth cone short and blunt ; maxillary palp 3-jointed, 45 μ long, individual joints measuring 19, 10, and 16 μ long respectively.

Prothorax 126 μ long, 140 μ wide at anterior margin and 168 μ across posterior margin. Prothoracic bristles very well developed ; anteroangulars shorter, 32 μ long, anteromarginals 51 μ long ; outer and inner postangulars 19 μ and 58 μ long respectively ; lateral margins on scale with smaller bristles, 19-22 μ long.

Forewings 700 μ long, 70 μ wide at base, 42 μ at middle and 35 μ tip.

Chaetotaxy : costa, 24 ; upper vein, 6 at base and 1 at tip ; lower vein, 11 in a row. Wing bristles well developed ; costal bristles 51 μ long ; basal lower vein bristles 48 μ long, distal one 67 μ long ; fringes 252 μ long.

Abdomen at base uniformly wide, 210 μ ; abdominal tergites devoid of lateral polygonal reticulations ; bristles of IX : outer 78, middle 102, and inner 112 μ long ; bristles of X : inner 99, outer 67 μ long.

Total body length 1.4 mm.

KODAIKANAL : Bryant's Park 7000′, 2 females on Arum lily (*Richardia* sp.) flowers, 6-6-1959.

Genus **BOLACOTHRIPS** Uzel

1895. *Bolacothrips* Uzel, H. *in* Mon. Ord. Thys. : 212.

This genus is being recorded for the first time in India and is characterised by the slender body, simple sense cones, 7-jointed antenna, 2 pairs of postocellar bristles and posterior prothoracic angles with a pair of bristles of about equal length.

Bolacothrips bicolor sp. nov.

Macropterous female :

Body bicolorous ; head and thorax yellow, with a greyish tinge ; antennae and abdomen brown. Wings pale at basal third, dark brown at middle, and pale brown at apex.

Head 112 μ long from fore margin of eyes, about as wide across eyes. Eyes well developed, postoculars 60 μ long, pointed. Antenna 7-jointed (Fig. 2), joints 3-7 measuring length (width) in μ : 45 (19), 45 (22), 38 (19), 49 (19), 16 (10). Sense cones on 3 and 4 simple. Mouth cone broadly rounded, 96 μ long, 80 μ wide at base, reaching beyond the middle of the prosternum. Maxillary palp 3-jointed, 38 μ long, individual joints measuring 13, 10, and 16 μ long respectively.

Prothorax 168 μ long with numerous well-developed bristles on scale. Anteromarginals 48 μ long ; outer postangulars 83 μ, inner 80 μ long. Pterothorax 280 μ long and 224 μ wide. Forewings 714 μ long, 64 μ wide at base, 48 at middle, and 35 at tip. Chaetotaxy: costa 22 ; upper vein, 6 at base and 1+1+1 beyond base ; lower vein 10 in a row.

Abdomen broad at base distinctly narrow at apex. Bristles of IX : outer 128, middle 196, and inner 64 μ long. Bristles of X : outer 90 and inner 105 μ long.

Total body length 1.4 mm.

KODAIKANAL: Bryant's Park 7000′, 1 female on *Agapanthus* flowers, 6-6-1959.

This is the only bicolorous species of *Bolacothrips* and hence easily distinguishable from the other species, *B. jordani* Uzel, *B. orientalis* Priesner, and *B. africanus* Faure.

Genus **RAMASWAMIAHIELLA** Karny

1926. *Ramaswamiahiella* Karny, H.H. *in* Mem. Dept. Agr. Ind., Ent. ser., (6) **9** : 208.

The genus *Ramaswamiahiella* is distinctly separated from the genus *Thrips* by the posterior margin of the sternites possessing at least 6 pairs of bristles.

Ramaswamiahiella kallarensis sp. nov.

Macropterous female :

General colour yellowish grey.

Antennal joint 1 pale, 2 dark grey, 3-7 yellowish grey. Wings pale greyish infumate ; abdomen uniform greyish brown.

Head wider than long, 126 μ wide and 84 μ long. Eyes large, 56 μ long and 42 μ wide. Antenna nearly 2.7 times head length ; antennal joints length (width) in μ : 22 (26), 32 (22), 35 (19), 38 (19), 35 (16), 45 (16), 13 (6).

Prothorax 140 μ wide across anterior margin 154 μ wide at posterior margin ; outer and inner postangular prothoracic setae 32 and 38 μ long respectively. Pterothorax as long as wide, 210 μ long. Wings 750 μ long, 70 μ wide at base; chaetotaxy : costa 27 ; upper vein 3+3 ; lower vein 16 in a row.

Abdominal segments broad at base gradually narrowed at apex. Bristles of IX : outer 64, middle 83, and inner 73 μ long. Bristles of X : inner 73 and outer 76 μ long.

Total body length 1.162 mm.

NILGIRIS : Kallar Fruit Research Station 1500′, 1 female on flowers of wood-apple among females of *Scirtothrips dorsalis*, 8-5-1959.

The present species differs from the only hitherto known species *subnudula* Karny by the larger size of the body and the difference in the chaetotaxy of the wings, particularly in the upper and lower veins. *R. subnudula* is a minute form measuring 0.75 to 0.95 mm.

Thrips florum Schmutz

1913. *Thrips florum* Schmutz *in* Sitz. Akad. Wiss. Wien. **122** : 1003.
1942. *Thrips florum* Karny, H.H. *in* Arkiv. Zool. **17** : 15.
1934. *Thrips florum* Priesner, H. *in* Natur. Tidschr. Neder. Inde. **94**: 261.
1940. *Thrips florum* Ramk. & Marg. *in* Cat. Ind. Insects, pt. 25 : 21-22.

NILGIRIS : Ootacamund, Raj Bhavan Gardens 7000′, several males and females on different species of roses, *Anemothecum*, *Hibiscus* flowers, and numerous other flowers of ornamental value (*vide infra*), and knol-kohl leaves, cabbage leaves, etc., 11-5-1959. KODAIKANAL : Shembaganur, Sacred Heart College Gardens 5500′, numerous females in flowers of *Agapanthus*, *Antirrhinum*, *Hibiscus*, *Crotalaria*, etc. ; Mt. St. Mary's 7500′, in flowers of *Iris*, *Anemothecum*, *Antirrhinum*, *Geranium*, *Verbena*, and different species of roses.

Thrips parvus Schmutz

1913. *Thrips parvus* Schmutz *in* Sitz. Akad. Wiss. Wien. **122** : 1004.
1926. *Thrips parvus* Karny, H. H. *in* Mem. Dep. Agri. Ind., Ent. ser., **6** : 199.
1934. *Thrips florum* Priesner, H. *in* Natur. Tidschr. Neder. Ind. **94** (3) : 268-269.

NILGIRIS : Burliar Fruit Research Station 2500′, 2 females on *Bauhinia* flowers, 8-5-1959.

This species is closely related to *Thrips florum* differing from it in the 3rd antennal joint being shorter than the 6th and the upper vein of fore-wing with 2 distal bristles while in *T. florum* the 3rd antennal joint is as long as 6 and upper vein has 3 distal setae.

Thrips apicatus Priesner

1934. *Thrips apicatus* Priesner, H. *in* Natur. Tidschr. Neder. Ind. **94** (3) : 264.

NILGIRIS: Ootacamund, Raj Bhavan Gardens 7000′, female on knolkohl leaves, 11-5-1959. KODAIKANAL ; Shembaganur, Sacred Heart College 5500′, numerous females on *Acacia podalyriaefolia* flowers, 5-6-1959.

This species has been hitherto known only from a single female collected on *Acacia* from Guntur and described by Priesner.

Thrips tabaci Lindeman

1888. *Thrips tabaci* Lindeman *in* Die Schadl. Ins. Tabac, 15.

1902. *Thrips tabaci* Hinds, W. E. *in* Proc. U.S. Nat. Museum **26** : 178-194.

1932. *Thrips tabaci* Ramakrishna, T. V. *in* Agr. & Livestk. Ind. **2** (4) : 394-395.

NILGIRIS : Ootacamund, Raj Bhavan Gardens 7000′, numerous males and females on carnations, 11-5-1959. KODAIKANAL : Mt. St. Mary's 7500′, on carnations numerous males and females; also on *Verbena venosa*, *Rosa bankia*, *Osbeckia*, *Agapanthus*, *Iris*, etc., 5-6-1959.

This species has a very wide distribution and is extremely polyphagous. The damage wrought by them to carnations in India has hitherto been unnoticed in spite of the attention it has received as the most harmful injurer in Europe, Britain, and the United States. The damage is evident from the numerous pale and blotched areas on the otherwise continuous beds of red and pink flowers. The flowers become dry and wrinkled and fade owing to heavy infestation. The early signs are the blotching of petals becoming white or silvery and subsequently turning light grey and finally brown. All the parts of the flowers were found to be attacked and several adults and larvae were observed inside each flower.

Thrips nilgiriensis Ramakrishna

1928. *Thrips nilgiriensis* Ramakrishna, T. V. *in* Mem. Dep. Agri. Ind., Ent. ser., (7) **10** : 262-263.

1940. *Thrips nilgiriensis* Ramakrishna, T. V. & Margabandhu, V. *in* Cat. Ind. Insects, pt. 25 : 23.

NILGIRIS : Ootacamund, Raj Bhavan Gardens 7000′, numerous females and males in flowers of broad beans (*Fabia vulgaris*) and flowers of peaches, plums, etc. 11-5-1959. KODAIKANAL : Shembaganur, Sacred

Heart College 5500′, numerous females in orchid flowers, *Habenaria*, *Cypripedium*, and *Dendrobium gratiosissimum*. Mt. St. Mary's 7500′, on carnations, Avocado inflorescence, Poppy flowers, and Goodlaea flowers, 5-6-1959.

Though an attempt to find the orchid thrips *Chaetanaphothrips orchidii* Moulton proved unsuccessful, the existence in fairly good numbers of *Thrips nilgiriensis* and *Haplothrips gowdeyii* (Franklin) on orchids of different kinds was recorded. *T. nilgiriensis*, from what can be inferred from its host range, seems to be gaining importance as one of the efficient injurers of flowers, especially at altitudes, since so far as known to the author their abundance in the plains is totally negligible. They are yellow forms having close resemblance to *Thrips palmi* Karny from which they are distinguished by the difference in the number of costal bristles, which even if considered to be within the normal range of variations, could be still separated by the position of the four setae on the IX tergite which are equidistant from each other in *palmi* while in *nilgiriensis* the two median setae are twice as wide apart as the lateral one from them.

Thrips bambusae Shumsher

1945. *Thrips bambusae* Shumsher Singh *in* Indian J. Ent. **7** : 182-184.

NILGIRIS : Raj Bhavan Gardens 7000′, numerous males and females on bamboo spindles, 11-5-1959 ; Coonoor, Sims Park 5500′, numerous males and females on bamboo spindles, 10-5-1959. KODAIKANAL : Shembaganur, Sacred Heart College 5500′, numerous males and females on bamboo spindles, 5-6-1959.

Thrips melaneurus Bagnall

1926. *Thrips melaneurus* Bagnall, R. S. *in* A. M. N. H. (9) **17** : 11.
1928. *Thrips melaneurus* Ramakrishna, T. V. *in* Mem. Dep. Agri. Ind., Ent. ser., (7) **10** : 262.

NILGIRIS : Ootacamund, Raj Bhavan Gardens 7000′, numerous females on *Rosa bankia*, 11-5-1959. KODAIKANAL : Mt. St. Mary's 7500′, numerous females and males on different species of rose.

This is a common species of thrips often found in the company of *Thrips florum* inhabiting rose flowers.

Thrips palmi Karny

1925. *Thrips palmi* Karny, H. H. *in* Bull. Deli. Proef. st. **23** : 10.
1926. *Thrips palmi* Karny, H. H. *in* Mem. Dep. Agri. Ind., Ent. ser., (6) **9** : 199.
1947. *Thrips palmi* Shumsher Singh *in* Indian J. Ent. **7** : 171.

NILGIRIS : Ootacamund, Raj Bhavan Gardens 7000′, numerous females on flowers of *Lathyrus*, 11-5-1959.

Heliothrips haemorrhoidalis Bouche

1833. *Heliothrips haemorrhoidalis* Bouche *in* Nat. Schadl. Garten Ins. : 206.

1902. *Heliothrips haemorrhoidalis* Hinds, W. E. *in* Proc. U.S. Nat. Mus. **26** : 168-169.

1940. *Heliothrips haemorrhoidalis* Ramakrishna, T. V. & Margabandhu, V. *in* Cat. Ind. Insects pt. 25 : 11-12.

NILGIRIS : Ootacamund, Botanical Gardens 7000′, 2 females on grass, 11-5-1959 ; Coonoor, Pomological Station 5500′, 5 females on grass, 10-5-1959. KODAIKANAL : Bryant's Park 7000′, numerous females on young pine needles, 6-6-1959.

Helionothrips kadaliphila (Ramakrishna & Margabandhu)

1931. *Heliothrips kadaliphila* Ramakrishna, T. V. & Margabandhu, V. *in* J. Bombay nat. Hist. Soc. **34** (4) : 1033.

1936. *Helionothrips kadaliphila* Priesner, H. *in* Proc. R. Ent. Soc. London (B) **5** : 208.

NILGIRIS : Kallar Fruit Research Station 1500′, numerous females and males on plantain leaves ; Burliar Fruit Research Station 2500′, numerous females and males on *Colocasia* leaves, 8-5-1959.

Caliothrips indicus (Bagnall)

1913. *Heliothrips indicus* Bagnall, R. S. *in* A. M. N. H. (8) **12** : 291.

1934. *Heliothrips indicus* Ramakrishna, T. V. *in* Agr. & Livestk. Ind. **2** (4) : 397.

1940. *Heliothrips indicus* Ramakrishna, T. V. & Margabandhu, V. *in* Cat. Ind. Insects pt. 25 : 12.

1947. *Hercothrips indicus* Shumsher Singh *in* Indian J. Ent. **7** : 175.

NILGIRIS : Coonoor Pomological Research Station, 5500′, 6 females on grass, 10-5-1959.

Suborder TUBULIFERA Haliday

Genus **STICTOTHRIPS** Hood

1924. *Stictothrips* Hood, J. D. *in* Psyche : 295.

Stictothrips fimbriata (Ananthakrishnan)

1953. *Thilakothrips fimbriata* Ananthakrishnan, T. N. *in* Proc. R. Ent. Soc. Lond. (B) **22** (3-4) : 33-34.

NILGIRIS : Coonoor Pomological Station 5500′, 1 female on grass, 10-5-1959.

Genus **HOPLOTHRIPS** Serville

1843. Serville *in* Hist. Nat. Ins. Hem. : 640.
1949. Priesner, H. *in* Bull. Soc. Fouad Ier. Entom. **33** : 86.
1957. Stannard, L. J. *in* Ill. Biol. Mon. (25) : 70-71.

The genus *Hoplothrips* is characterised by the head distinctly longer than broad, fore femora not or slightly enlarged, mouth cone long, sides straight, at least attaining mesosternum and the terminal antennal joints not forming a unit. This genus has hitherto been unrepresented in India. All the same, according to Stannard (1957), the genus *Hoplothrips* is synonymous with *Phlaeothrips* Haliday. However, pending further discussions, the genus is retained as such here.

Hoplothrips indicus sp. nov.

Macropterous female :

General body colour brownish yellow ; head, thorax, all femora except at apex, abdominal segments IV-X and antennal joints 5-8, brown; antennal joints 2 and 3, all tibia, tarsi, and apex of femora yellow ; joint 1, abdominal segments II and III yellow, shaded with brown.

Head 238 μ long, 196 μ across eyes, 182 μ across cheeks, and 168 at base, distinctly constricted at base (Fig. 3 A). Eyes 70 μ long, 75 μ wide at middle. Postoculars dilated, well developed, 64 μ long, placed 16 μ from cheeks. Ocelli placed forward, posterior ocelli beyond middle line of eyes, median ocellus at vertex not very much over-hanging. Median ocellus 19 μ in diameter, placed 13 μ from posterior ocelli, 29 μ apart and 16 μ in diameter. Antenna 8-jointed, joints 5, 6, and 7 pedicellate (Fig. 3 a) ; sense cones long and well developed ; 3^{1+1}; 4^{1+1} ; 5^{1+1} ; 6^{1+1} ; antennal joints length (width) in μ : 48 (38), 64 (32), 80 (32), 83 (35), 69 (32), 64 (32), 54 (29), 32 (18). Mouth cone very long reaching just beyond the base of the prosternum, 224 μ long.

Prothorax 224 μ long at middle, as wide at anterior margin, and 223 μ at base inclusive of coxae. Prothoracic bristles moderately long, dilated. Anteroangulars 43 μ ; postangulars 58 μ ; epimerals 64 μ long. Fore femora moderately enlarged, 112 μ wide at middle, foretarsus with a triangular tooth, 16 μ long and 13 μ wide at base. Wings reaching VI abdominal segment, not constricted at middle.

Abdomen broad at base, uniformly wide across segments II-V, 448 μ ; segment VIII 322 μ wide, IX 154 μ wide; bristles of IX outer ones long and fine, inner short and infundibuliform, 65 μ long. Tube 140 μ long, 84 μ wide at base, 56 at middle and 42 at tip. Anal setae as long as tube. Total body length 2.240 mm.

Nilgiris : Coonoor Pomological Station 5500′, female on *Lantana* flowers, 10-5-1959.

Bamboosiella bicoloripes Ananthakrishnan

1957. *Bamboosiella bicoloripes* Ananthakrishnan, T. N. *in* Ent. News **68** (3) : 65-68.

The discovery of more males and females of this species from bamboo spindles adds considerably to our knowledge of the range of variations of this form noted particularly for its long and thin sense cones and short mouth cone with short stylets confined only to the mouth cone.

Macropterous female :

Head 238-294 μ long from front margin of eyes, 196-210 μ wide across eyes, 203 across cheeks, and 182 at base. Posterior cheek bristle 19 μ long. Eyes 98-126 μ long, 56-84 μ wide at middle. Median ocellus 19 μ in diameter placed 22 μ from posterior ocelli, 22 μ in diameter and 32 μ apart. Postoculars 64-77 μ long, placed 29-32 μ from cheeks and 22-26 μ from posterior margin of eyes. Antennal joints length (width) in μ : 35-38 (35-38), 51-58 (26-32), 77-83 (26-32), 83-93 (36-32), 70-83 (26-32), 58-70 (26-29), 45-54 (22), 32-35 (13).

Prothorax 168-210 μ long, 168-238 μ wide at anterior margin, and 350 μ at base. Prothoracic setae : anteroangulars 32-45 μ ; midlaterals 35-48 μ ; postangulars 56 μ ; epimerals 58-64 μ long. Pterothorax 294-350 μ long and 378 μ side. Forewings 812-910 μ long ; basal wing bristles, 38 μ, 45-48 μ, and 64-78 μ long.

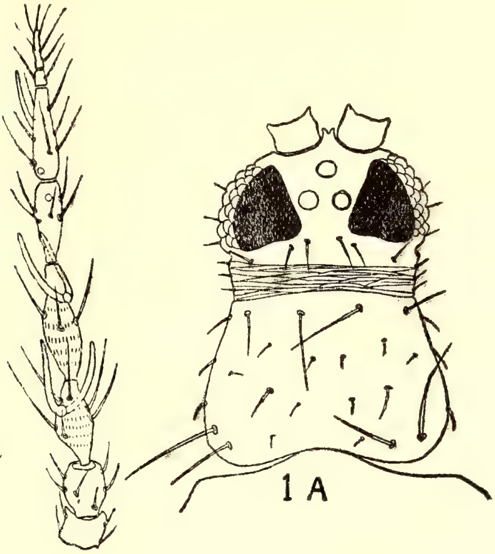
Bristles of abdominal segment IX : outer 173, middle 167, and inner 143 μ long. Tube 168 μ long. Total body length 1.862 to 2.492 mm.

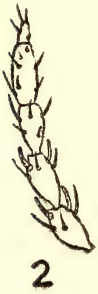
Macropterous male :

Head, length 217-252 μ, 154-182 μ wide across eyes, and 168 at base. Eyes 91-98 μ long and 70 μ wide. Median ocellus 19 μ in diameter, placed 26 μ from posterior ocelli, 19 μ in diameter and 26 μ apart. Postoculars 54-67 μ long placed 16 μ from cheeks and 22 μ from eye margin. Antennal joints length (width) in μ : 26-29 (32), 48-51 (32), 70-77 (29-32), 75-78 (29-32), 63-70 (22-26), 48-51 (22), 45 (19), 32 (13).

Prothorax 168-182 μ long at middle, 182-210 μ wide anteriorly, and 280-308 μ at posterior margin inclusive of coxae. Anteroangulars 29-32 ; epimerals 51-57 μ long. Forewings 770-810 μ long. Bristles of IX : outer 141-144 and inner 160-172 μ long. Tube 140 μ long.

Nilgiris : Kallar 1500′, 5 females and 3 males on bamboo spindles, 9-5-1959.





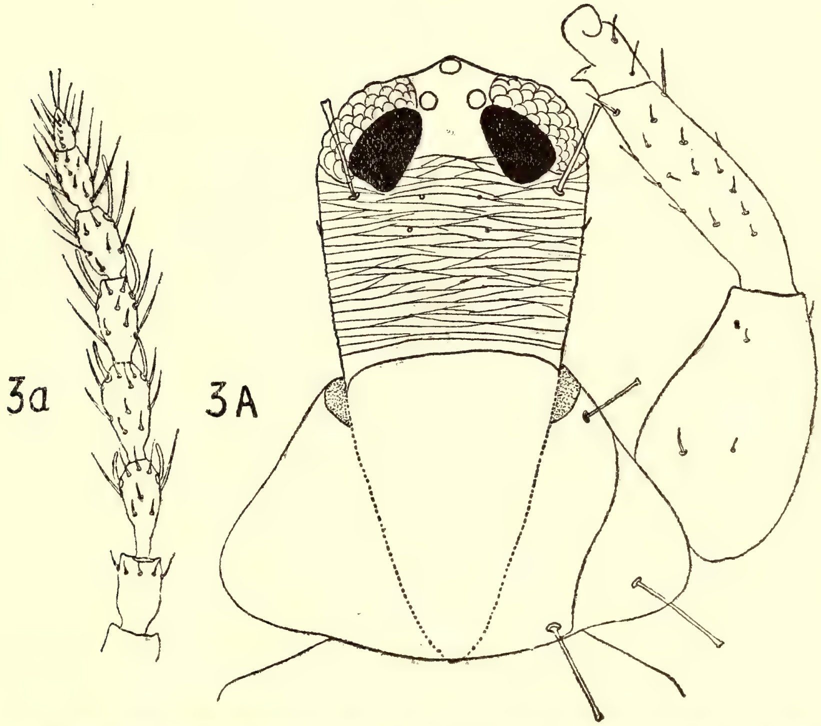
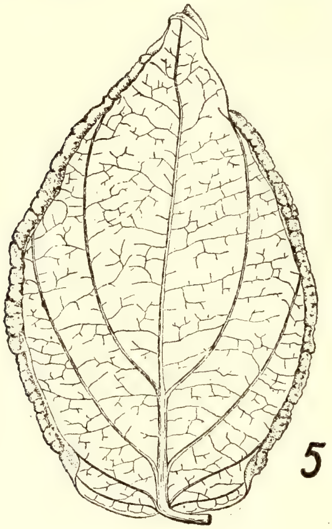
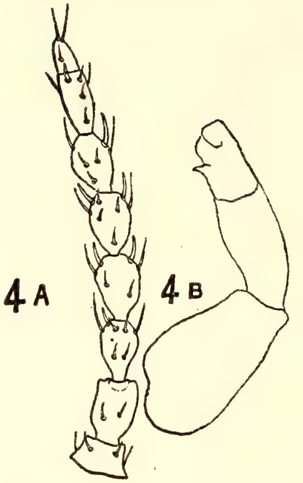


Fig. 1. *Aroidothrips longistylus* sp. n. × 110: 1A. Head and prothorax of female; 1a. Antenna of female. Fig. 2. *Bolacothrips bicolor* sp. n. × 110: Antennal joints 3-7 of female. Fig. 3. *Hoplothrips indicus* sp. n. × 110: 3A. Head, prothorax, and forelegs of female; 3a. Antenna of female.





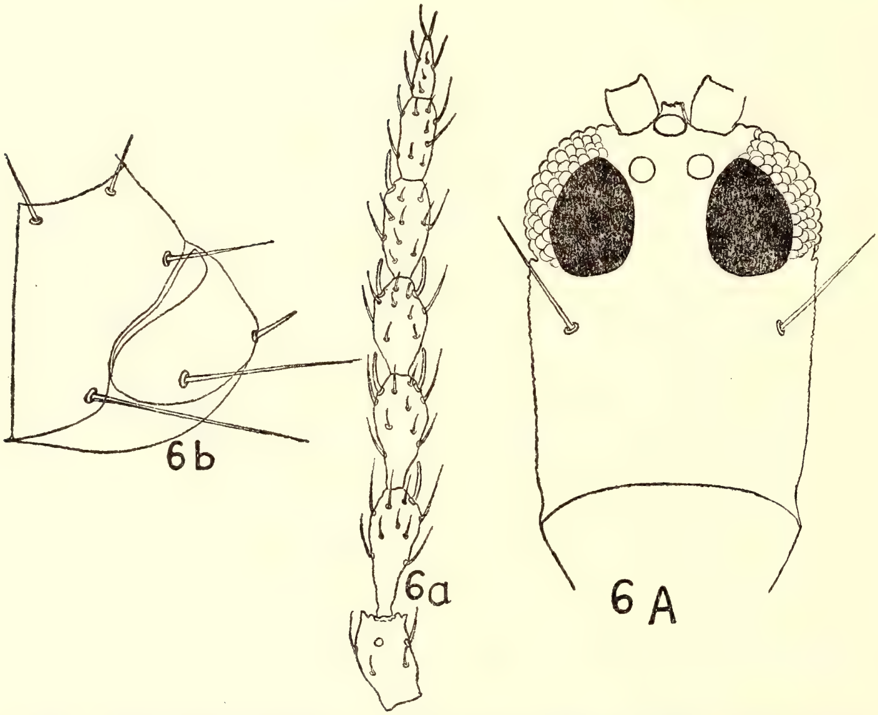


Fig. 4. *Apterygothrips pini* sp. n. × 110 : 4A. Antenna of female ; 4B. Foreleg of female. Fig. 5. Marginal leaf gall of pepper, formed by *Gynaikothrips karnyi* Bagnall. Fig. 6. *Gynaikothrips karnyi* Bagnall × 110: 6A. Head of female ; 6a Antenna of female ; 6b. Prothoracic chaetotaxy (one half).

Haplothrips (Trybomiella) ramakrishnai Karny

1926. *Haplothrips ramakrishnai* Karny, H. H. *in* Mem. Dept. Agri. Ind., Ent. ser., **9** (6) : 218.

1928. *Haplothrips ramakrishnai* Ramakrishna, T. V. *in* ibid. (7) : 10 292.

1931. *Haplothrips ramakrishnai* Ramakrishna, T. V. & Margabandhu, V. *in* J. Bombay nat. Hist. Soc. **34** (4) : 1038.

1933. *Haplothrips ramakrishnai* Priesner, H. *in* Rec. Ind. Mus. **25** : 361.

1957. *Haplothrips* (*Trybomiella*) *ramakrishnai* Ananthakrishnan, T. N. *in* Zool. Anz. **159** : 100-101.

KODAIKANAL : 6000′, several males and females on flowers of *Ageratum conizoides*, a very common roadside plant. Mt. St. Mary's 7500′, 10 females and 6 males in flowers of Hollyhock ; 4 females and 2 males of Gerbera inflorescence, 5-6-1959. Bryant's Park 7000′, numerous males and females on Canna leaves, 5-6-1959.

It is of interest to note that only two species of *Trybomiella* are known from India, *T. ramakrishnai* and *T. apicalis* Priesner. *T. apicalis* is a typical grass-infesting form pale yellowish brown to golden brown in colour and head 1.2-1.3 times as long as wide, while *ramakrishnai* has not been recorded from grasses and is pale chestnut brown in colour with head as long as wide. Though *T. tirumalraoi* Ramk. & Marg. has been described from a single male, closer examination will reveal that it is a possible synonym of *ramakrishnai.*

Haplothrips gowdeyii (Franklin)

1908. *Anthothrips gowdeyii* Franklin, H. J. *in* Proc. U.S. Nat. Mus. **33** : 724.

1910. *Anthothrips gowdeyii* Bagnall, R. S. H. *in* Thysanoptera-Fauna Hawaiiensis **3** : 669-701.

1931. *Haplothrips gowdeyii* Priesner, H. *in* Bull. Soc. Roy. Ent. Egypt : 261.

1933. *Haplothrips gowdeyii* Priesner, H. *in* Rec. Ind. Mus. **35** : 354.

1937. *Haplothrips gowdeyii* Sakimura, K. *in* Proc. Haw. Ent. Soc. **9** (3) : 422.

The occurrence of this thrips in considerable numbers on a variety of plants, in particular on orchids and hollyhocks, and the damage it causes to the latter in particular are an addition to our knowledge of the bionomics of this form in India, especially when the only hitherto available data in our country is its record on *Solanum* leaves. It can be ranked as one of the commonest Tubulifera in our country and when one realises its world-wide distribution, having a very wide host range, being extremely common in flowers of different kinds, it is difficult to imagine that its role as a major horticultural pest has been overlooked. Its importance lies in its polyphagous nature, feeding on flowers and leaves, its relative population density, and its ability to breed on most of the plants it infests. Several individuals were found in groups, feeding around the base of the ovary inside the hollyhocks. The infestation proved to be severe in the bud condition.

KODAIKANAL : Mt. St. Mary's 7500′, hollyhock flowers, numerous males and females, 5-6-1959. Bryant's Park 7000′, numerous individuals on leaves of Canna and grass, 5-6-1959.

Haplothrips euphorbiae Priesner

1931. *Haplothrips euphorbiae* Priesner, H. *in* Miscellanea Zoologica Sumatrana **58** : 1-4.

NILGIRIS : Kallar 1500′, several males and females collected on leaves of *Euphorbia hirta*, 8-5-1959.

This species is a new record to India and is responsible for the malformation of the leaves and in extreme cases the leaves become severely damaged.

Xylaplothrips pictipes (Bagnall)

1919. *Haplothrips pictipes* Bagnall, R. S. *in* A. M. N. H. (9) **3** : 273.

1925. *Haplothrips pictipes* Ramakrishna, T. V. *in* J. Bombay nat. Hist. Soc. **30** : 868.

1928. *Haplothrips pictipes* Ramakrishna, T. V. *in* Mem. Dept. Agr. Ind., Ent. ser., (7) 10 : 292.

1933. *Haplothrips pictipes* Priesner, H. *in* Rec. Ind. Mus. **25** (3) : 351.

1938. *Xylaplothrips pictipes* Crawford, J. C. *in* Proc. Ent. Soc. Wash. **40** (2) : 42.

NILGIRIS : Kallar Fruit Research Station 1500′, 4 males and 5 females on cashew inflorescence, 8-5-1959.

Xylaplothrips Priesner has delicate, slender body form and the females of *pictipes* in this collection range between 1.204-1.498 mm. in length and the males from 1.064-1.115 mm. *X. pictipes* (Bagnall) is distinguished from *X. nayari* Ananthakrishnan by the presence of the foretarsal tooth in both the sexes.

Dolichothrips (Dolicholepta) rambhutanae sp. nov.

Macropterous female :

General colour brown ; all tarsi, foretibia except at base, antennal joints 2-7 yellow ; rest of body brown. Wings colourless, Head, 210-224 μ long, 168 μ wide across eyes and 154 at base, distinctly constricted at base and 1.3 times as long as wide across cheeks. Eyes 98 μ long and 70 μ wide. Ocelli well developed, median ocellus overhanging vertex, 16 μ in diameter, placed 19 μ from posterior ocelli 22 μ apart and 16 μ in diameter. Postoculars 48 μ long and blunt at tip. Antennal joints length (width) in μ : 29-32 (32), 48-51 (32), 61-64 (29-32), 64-70 (32), 54-58 (29), 48-51 (26), 45-48 (22), 26 (13). Mouth cone 182 μ long, 126 μ wide at base, 56 at middle, and 28 μ at tip, sides biconcave and tip reaching the base of prosternum. Maxillary palpi 64 μ long and labial palpi 19 μ long.

Prothorax 182-210 μ long at middle, 162-168 μ wide across anterior margin, and 266-308 μ wide at base inclusive of coxae. Prothoracic bristles, short and dilated at tip. Anteroangulars 26 μ, postangulars 32 μ, epimerals 38 μ long. Forefemora 84 μ wide at middle, foretarsus with a small, inconspicuous tooth.

Pterothorax 350 μ long and 336 μ wide at middle. Wings clear, constricted at middle, reaching VII abdominal segment with 8 duplicate cilia. Bristles on scales 42, 38, and 51 μ long respectively.

Abdomen broad at base, 322 μ wide, 280 μ wide across segment IV, 266, 224, and 112 μ wide across segments VII, VIII, and IX. All the 3 bristles of segment IX subequal, 150 μ long. Tube 168 μ long, 70, 56, and 42 μ wide at base, middle, and apex respectively ; anal setae long and fine, longer than tube, 210 μ long.

Total body length 1.904-2.324 mm.

Macropterous male :

Head 224 μ long, 154 μ wide across cheeks, and 133 μ wide at base. Eyes 84 μ long and 63 μ wide. Postoculars 48 μ long. Median ocellus 13 μ in diameter, placed 16 μ from posterior ocelli, 16 μ in diameter and 29 μ apart. Antennal joints length (width) in μ : 22 (29), 45 (26), 67 (29), 67 (29), 58 (26), 54 (22), 48 (16), 29 (10). Mouth cone 98 μ wide at base and 28 μ wide at tip.

Prothorax 196 μ long at middle, 140 μ wide at anterior margin, and 280 μ wide at posterior margin. Anteroangulars 19 μ, postangulars 43, and epimerals 35 μ long. Forefemora 84 μ wide at middle with foretarsal tooth slightly more developed than in the female.

Pterothorax 294 μ wide and 308 μ long at middle. Wing scale bristles 43, 38, and 51 μ long respectively.

Abdomen long and thin, 224, 182, 126, and 98 μ wide at base, at middle, and across VIII and IX abdominal segments respectively. Bristles of IX subequal, 128 μ long. Tube 168 μ long, 56 μ wide at base ; anal setae 224 μ long.

NILGIRIS : Kallar Fruit Research Station 1500′, 13 females and 3 males on inflorescence of Rambhutan, 9-5-1959.

Praepodothrips indicus Priesner & Seshadri

1952. *Praepodothrips indicus* Priesner, H. & Seshadri, A.R. *in* Ind. Jour. Agri. Res. **22** (2) : 408-409.

KODAIKANAL : Perumalmalai Hills 5000′, 4 females from sheaths of wild grass, 4-6-1959. NILGIRIS : Coonoor Pomological Station 5500′, one female on perennial rye grass, 10-5-1959.

A typical grass-inhabiting form, this species is represented only in India and shows a distinct tendency towards oedymerism.

Praepodothrips priesneri Ananthakrishnan

1955. *Praepodothrips priesneri* Ananthakrishnan, T. N. *in* A. M. N. H. **12** (3) : 608.

NILGIRIS : Coonoor, Sim's Park 5500′, 2 females on bamboo spindles, 10-5-1959.

This is a typical bamboo leaf and sheath infesting form, purely monophagous whether it be on the plains or hills.

Praepodothrips cymbopogoni Ananthakrishnan

1957. *Praepodothrips cymbapogoni* [*sic*] Ananthakrishnan, T. N. *in* Zool. Anz. 157 : 136-138.

NILGIRIS : Coonoor Pomological Station 5500′, several females and males inside the leafsheath of lemon grass, *Cymbopogon citratus*, 10-5-1959.

It is of interest to note that, of the three species of *Praepodothrips*, *priesneri* and *cymbopogoni* are monophagous while *indicus* has been seen to feed on different kinds of grasses.

Genus **APTERYGOTHRIPS** Priesner

1933. Priesner, H. *in* Bull. Soc. Roy. Ent. Egypte : 1-3.

Body very small, wings and ocelli absent. Joint 3 of antenna short, broad at apex. Prothorax broader and shorter than head. Pterothorax narrower than prothorax including coxae. Forefemora little enlarged in the male, without teeth ; foretarsi with a distinct tooth in both the sexes, shape as in *Karnyothrips*. Tube very short, conical.

Apterygothrips pini sp. nov.

Female :

General body colour brown with yellow pigment. Antennal joints 1-2, 7-8 more brownish yellow ; joints 3-6 yellowish brown. Tube except at apex yellow. Body with scattered red pigment. Abdominal segments with more of yellow suffused with brown.

Head 147-154 μ long from eye margin, 140 μ wide across eyes, and 140-147 μ wide across cheeks. Eyes 48 μ long, 45 μ wide at middle,being 51 μ wide at interocular region. Postoculars 35-38 μ long, slightly dilated at apex. Antenna 8-jointed (Fig. 4A), joint 3 short, with a pedicel and with one small sense cone. Antennal joints length (width) in μ: 32 (29), 45 (29), 35-38 (22), 38-43 (29), 43 (26), 38-41 (26), 43 (22), 26-29 (13). Mouth cone 98 μ long reaching just the hind margin of the prosternum, blunt.

Prothorax 140 μ long at middle, shorter than head, 168 μ wide across anterior margin, and 224 μ at base inclusive of coxae. Prothoracic bristles short, dilated at tip. Anteroangulars 16 μ; postangulars 29; epimerals 38 and coxals 19 μ long. Pterothorax 168 μ long, 172 μ wide. Forefemora moderately enlarged, 70 μ wide, foretarsus with small tooth (Fig. 4B).

Abdomen 224 μ wide at base, 308 μ wide across segments V and VI, 140 across VIII, and 126 across IX segment. Setae on IX short and fine; outer 35-48, middle 26-32, and inner 48-60 μ long. Tube 83-90 μ long, 60 μ wide at base, 43 at middle, and 32 at tip; anal setae 80 μ long.

Total body length 1.26-1.41 mm.

Male:

General colour as in the female, more brownish. Head, thorax, and legs darker brown, as also antennal joints 3-6.

Head 140 μ long, 126 μ wide across eyes. Eyes 45-48 μ long and as wide. Postangulars 29 μ long. Antennal joints, length (width) in μ: 29 (26), 44 (26), 38 (22), 43 (26), 43 (26), 35 (22), the last two joints missing. Prothorax 126 μ wide at anterior margin, 196 at posterior margin, and 140 μ long at middle. Prothoracic bristles: anteroangulars 16 μ long; postangulars 29; epimerals 35; coxals 19 μ long. Forefemora not enlarged, 56 μ wide at middle, foretarsi with a small tooth.

Abdomen at base 196 μ wide, 98 μ across segment IX. Setae of IX: outer 45, middle 26, inner 51 μ long. Tube 86 μ long, 54 μ wide at base, 38 at middle, 29 at tip.

Total body length 1.218 mm.

KODAIKANAL: Bryant's Park 7000′, 3 females and 2 males on pine needles, 4-6-1959.

Only four species of this genus have hitherto been known, *haloxyli* Priesner, *luteus* Faure, *carolinae* Faure, and *flavus* Faure. *A. pini* is very closely allied to *A. haloxyli* but is easily distinguishable by the difference in the chaetotaxy of the body and in the dilated pronotal bristles.

Gynaikothrips karnyi Bagnall

1914. *Gynaikothrips karnyi* Bagnall, R. S. *in* A. M. N. H. **13** : 23-31.

1952. *Gynaikothrips karnyi* Ananthakrishnan, T. N. *in* Indian J. Ent. **14** : 201.

Except for a casual reference to the record of 2 females by Ananthakrishnan (1952) nothing has been known about this interesting gall making thrips from India. The original reference to this species by Bagnall from leaf galls on pepper (Fig. 5) from Ceylon does not comply with modern concepts, particularly in the absence of any mention of the prothoracic chaetotaxy (Fig. 6b) especially the postangulars and the epimerals. Further, no mention is made of the sex described and, from a comparison of the several individuals at the disposal of the author, what Bagnall described appears to be a male, since the range of body length of the males in the author's collection tallies with that of Bagnall's specimen.

Macropterous female :

Total body length 2.59-2.80 mm. Head, length 280-308 μ, width across cheeks 210-224 μ. Postoculars 89-96 μ. Eyes, length 112 μ, width 84 μ. Antennal joints, length (width) μ : 48-54 (48), 64-70 (35-38), 83-93 (32), 77-86 (38), 74-80 (35), 74-83 (32-35), 64-67 (29), 45-48 (16).

Prothorax, length 196 μ, width at anterior margin 280 μ, at posterior margin 448 μ. Prothoracic bristles : anteroangulars 42-48 μ; anteromarginals 58-64 μ ; midlateral 109 μ ; postangulars 147-153 μ ; epimeral 128-144 μ long.

Pterothorax, length 448 μ ; width at base 462 μ ; at middle 490 μ. Forewings, length 952-1008 μ, 98-126 μ wide at base, 84-98 μ at middle, and 70-84 μ at tip. Tube 210-232 μ long.

Male :

Total body length 1.92-2.18 mm. Head, length 266-280 μ ; width 196-203 μ. Postoculars 77-90 μ. Antennal joints, length (width) μ : 48-52 (43), 58-61 (32), 77-80 (32), 67-70 (32-35), 70-73 (32), 70 (29-32), 60 (26), 43 (13).

Prothorax, length 154 μ ; width at anterior margin 238 μ, at posterior margin 350 μ. Prothoracic bristles ; anteroangulars 35-38 μ, anteromarginals 45-48 μ ; midlaterals 86-92 μ. Postangulars 144 μ ; epimerals 128-134 μ. Pterothorax, length 350 μ, width 378 μ. Forewings length 994 μ ; 84, 70, and 70 μ wide at base, middle and tip. Tube length 172 μ.

NILGIRIS : Kallar 1400′, Burliar 2500′, numerous males and females from marginal leaf galls of pepper.

Gynaikothrips interlocatus Karny

1926. *Gynaikothrips interlocatus*, Karny, H. H. *in* Mem. Dept. Agr. Ind., Ent. ser., (6) **9** : 237-238.

Nilgiris : Burliar 2500′, female on leaf of wild plant, 8-5-1959.

Cercothrips tibialis (Bagnall)

1921. *Gynaikothrips tibialis* Bagnall, R. S. *in* A. M. N. H. **7** (9) : 264-265.
1926. *Gynaikothrips tibialis* Karny, H. H. *in* Mem. Dept. Agr. Ind., Ent. ser., **9** : 239.
1934. *Cercothrips tibialis* Ramakrishna, T. V. *in* Rec. Ind. Mus. **36** : 498.

Nilgiris : Kallar 1400′, numerous males and females on *Ficus bengalensis*, 8-5-1959.

List of species of Thrips common on some of the ornamental plants of Ootacamund and Kodaikanal hills

Host Plant	Name of Species
Agapanthus	*Thrips tabaci* Lind. *Thrips florum* Schmutz *Frankliniella sulphurea* Schmutz
Anemothecum	*Thrips melaneurus* Bagnall *Thrips florum* Schmutz
Antirrhinum	*Thrips florum* Schmutz
Canna	*Haplothrips* (*Trybomiella*) *ramakrishnai* Karny *Haplothrips gowdeyii* (Franklin)
Coreopsis	*Haplothrips* (*Trybomiella*) *ramakrishnai* Karny *Thrips tabaci* Lind.
Carnations	*Thrips tabaci* Lind. *Taeniothrips simplex* (Morrison) *Frankliniella sulphurea* Schmutz
Coelogyne	*Haplothrips gowdeyii* (Franklin)
Cymbidium bicolor	*Heliothrips haemorrhoidalis* Bouche *Haplothrips gowdeyii* (Franklin)
Delphinium	*Thrips tabaci* Lind. *Thrips florum* Schmutz
Dendrobium sp.	*Haplothrips gowdeyii* (Franklin)
Fabia vulgaris	*Thrips nilgiriensis* Ramakrishna

Geranium	*Thrips florum* Schmutz *Heliothrips haemorrhoidalis* Bouche
Gladiolus	*Taeniothrips simplex* (Morrison)
Goodlaea	*Xylaplothrips pictipes* Bagnall *Thrips nilgiriensis* Ramakrishna
Habenaria	*Thrips nilgiriensis* Ramakrishna
Hollyhock	*Haplothrips gowdeyii* (Franklin) *Haplothrips* (*Trybomiella*) *ramakrishnai* Karny
Iris	*Thrips tabaci* Lind. *Thrips florum* Schmutz *Frankliniella sulphurea* Schmutz *Heliothrips haemorrhoidalis* Bouche *Taeniothrips simplex* (Morrison)
Lathyrus sp.	*Thrips nilgiriensis* Ramakrishna
Limonium	*Thrips florum* Schmutz
Osbeckia	*Thrips tabaci* Lind.
Phlox sp.	*Thrips florum* Schmutz
Richardia sp.	*Haplothrips gowdeyii* (Franklin) *Heliothrips haemorrhoidalis* Bouche *Thrips florum* Schmutz
Rosa bankia	*Thrips tabaci* Lind. *Thrips melaneurus* Bagnall *Thrips florum* Schmutz
Rosa leschenaultii	*Thrips palmi* Karny *Thrips florum* Schmutz
Rosa multiflora	*Thrips tabaci* Lind.
Salvia sp.	*Thrips florum* Schmutz *Thrips tabaci* Lind.
Saponaria	*Thrips florum* Schmutz
Verbena venosa	*Thrips florum* Schmutz *Thrips tabaci* Lind.

A Systematic and Ecological account of the Cyanophyceae of Hoshiarpur

BY

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(*With twelve figures*)

The study of blue-green algae has been quite neglected in the Panjab as very few workers have ventured to study the cyanophycean flora of this region. Ghose (1919, 1923) was the pioneer worker who made an extensive study of the blue-green algae of Lahore (now in Pakistan) and Simla. After Ghose, Randhawa (1936) contributed to our knowledge of this group. Gupta (1950) has also contributed to the algal flora of Khajar-Chamba State. Apart from the publications of these authors no other work on the Cyanophyceae of the Panjab has appeared.

With a view to explore the cyanophycean flora of the Panjab the author started making extensive collections of these forms from district Hoshiarpur and its vicinity in the year 1958. Since then a systematic study of the material collected is being made and the author is now in a position to publish accounts of the material collected. The present paper incorporates descriptions and records of the blue-green algae from a part of the collection of the author. Future papers in this series will include systematic accounts of further instalments of Cyanophyceae from Hoshiarpur. Further collections are still being made and some of the material has revealed new and very interesting species.

District Hoshiarpur is situated between the rivers Sutlej and Beas and contains a chain of ponds and *choes*. The *choes* are seasonal torrential streams which sweep down the plains during the rainy season and have a large number of *chhambs* or swamps situated by their sides. These *chhambs* are annually replenished by the water of the *choes*. In addition there are a large number of tanks and water reservoirs which afford unique opportunities for algal collection. The large number of temporary and semi-permanent ponds and ditches, situated by the sides of the railway track and the roads, contain an immense wealth of algae during and a little after the monsoons.

Hoshiarpur is a sub-mountainous district of the Jullundhur division comprising so much of the Siwalik Range as lies between latitude 32° 5′

and 30° 58′ north, and longitude 76° 41′ and 75° 31′ east. Its elevation is about 1050 feet (320 m.) above sea-level. The average rainfall is 36″ (914 mm.) of which 30″ (762 mm.) are recorded in the months of July to September and the remaining 6″ (152 mm.) in the winter months. The hottest months are May and June, with a mean maximum temperature of 106° F. (41° C.). The mean minimum temperature is 40°F. (4.4° C.) in the months of December and January.

The Cyanophyceae can be collected throughout the year but they are met with in great abundance during the months of September to April. They are at their height of vegetative activity from September to February. Specimens collected from February to April show an extensive spore formation. Some forms like *Nodularia spumigena* Mertens, *Aulosira fertilissima* var. *tenuis* Rao, *Gloeotrichia raciborskii* Wol., *Cylindrospermum musicola* Kütz., and *C. alatosporum* Fritsch have been observed in sporulation during the months of November and December.

With regard to habitat, the Hoshiarpur Cyanophyceae described herein may be easily separated into the following ecological groups :

I. AQUATIC FORMS : This includes forms that are encountered strictly in water. The aquatic forms fall into two distinct habitat groups :

(i) FLOWING WATERS : Cyanophyceae growing in such habitats are always attached to the substratum, to which they stick by secreting a cement-like material. *Nostoc verrucosum* Vauch. forms extensive olive-coloured strata on the rocky beds of rapidly flowing streams.

(ii) STAGNANT WATERS : To this category belong a large number of Cyanophyceae that can be discussed under the following sub-headings :

(a) *Planktonic or free-floating forms :* These include a large number of tiny unicellular and colonial forms, and filamentous Cyanophyceae that may float on the surface of water in the form of mucilaginous, gelatinous, papery, or woolly strata.

Microcystis aeruginosa Kütz. forms the so-called ‘water bloom’ of dull green colour in quiet waters of most of the permanent and semi-permanent ponds. Since it occurs in considerable numbers and occupies the whole surface of water, it may be grouped under the Baltic type of algal plankton. *Aphanothece microscopica* Nag. was found forming small sub-globose or amorphous colonies floating on the surface of the water in a permanent pond and can be classified under the Caledonian type of algal plankton. The above two species have their colonial masses flattened and this gives sufficient buoyancy to keep them afloat.

Anabaena mehrai sp. nov. and *Cylindrospermum distinctum* sp. nov. are free-floating in ponds and ditches ; although these species possess single trichomes, the presence of gas vacuoles affords them the necessary buoyancy to keep them afloat.

Lyngbya spiralis Geitler is free-floating mixed with other algae. *Cylindrospermum musicola* Kütz. occurs in the form of flocculent free-floating masses of mucilaginous consistency and is usually mixed with other algae.

Aulosira prolifica Bharad., *Anabaena oscillarioides* var. *crassa* var. nov., and *A. iyengarii* var. *tenuis* Rao form gelatinous free-floating masses near the banks of ponds and other natural water reservoirs.

(b) *Benthic forms :* These are blue-green algae growing fixed to the bottom of ponds, lakes, and streams, or attached to vegetation or other objects in the water. *Lyngbya gardneri* Geitler forms yellowish green tufts at the bottom of many ponds ; this species is attached to the substratum by means of a lower or a basal cell which becomes basally flattened and discoid. *Lyngbya perelegans* Lemm. forms an abundant blue-green microscopic vegetation on soil at the bottom of ponds ; it has no special organs of attachment and forms prostrate or semi-erect masses of filaments which can easily be swept from one place to another by even a slight disturbance in the water.

Oscillatoria claricentrosa forma *bigranulata* Rao grows along walls of *pukka* tanks and is mixed with other species of the same genus. *Nostoc linckia* Born. has also been encountered from the sides of a *pukka* drain.

Anabaena vaginicola Fritsch et Rich. usually grows attached to other submerged water plants.

II. AMPHIBIOUS FORMS : There are a number of species that are abundant and thrive both on moist soil (sub-aerial habitat) and in stagnant waters (aquatic habitat). Such forms may be recorded as amphibious blue-green algae. *Cylindrospermum musicola* Kütz., *C. alatosporum* Fritsch, and *Nostoc ellipsosporum* Rabenh. can easily be referred to this group, and may be treated as amphibious blue-green algae that show a tendency towards sub-aerial habitat.

III. AERIAL FORMS : Cyanophyceae included under this heading grow mainly upon the bark and leaves of trees, and upon stones and walls. *Lyngbya palmarum* Brühl et Biswas has been found in abundance on trunks of palm trees. During the rainy season it forms an extensive, dark-coloured growth, but during the dry months of the year the colour of the thallus becomes yellowish or pale green. A substantial number of the species of *Scytonema* grow on the *pukka* walls of houses and on rocks.

IV. SUB-AERIAL FORMS : The blue-green algae referred to this group grow mainly upon moist soil in patches. *Cylindrospermum musicola* Kütz., *C. alatosporum* Fritsch, *Nostoc ellipsosporum* Rabenh., and *Lyngbya allorgei* Frémy are some of the common forms that can be found growing on moist soils. Several species of *Phormidium*, *Microcoleus*, *Scytonema*, and *Tolypothrix* can be included under this heading. Species of *Phor-*

midium form yellowish brown to blue-green strata that sometimes cover extensive areas. Species of *Scytonema* grow in black patches on moist soil.

The present paper records 25 species belonging to ten genera. Two new species and one new variety have been described. *Anabaena vaginicola* Fritsch et Rich. has been reported for the first time from India.

SYSTEMATIC ENUMERATION OF THE SPECIES OBSERVED

Order CHROOCOCCALES Wettstein

Family CHROOCOCCACEAE Nageli

MICROCYSTIS Kützing

1. **Microcystis aeruginosa** Kütz. Tab. Phycol. 1 : 8, pl. 8, fig. 1, 1846 ; Geitler in Rabenh. Kryptogam. Europa 14 : 136 ; fig. 59d, 1930-32 ; Crow in New Phytol. 22 : pl. 1, fig. a, 1923 ; Frémy, Myxo. Afr. Equat. Franc. 18, fig. 15, 1929 ; Tilden, Minnesota Algae 1 : pl. 2, figs. 21 & 22, 1910 ; Frémy, Cyano. Cotes Eur. 10, pl. 1, fig. 6, 1933. *Clathrocystis aeruginosa* (Kütz.) Henfry, J. Roy. micr. Soc. 53 : pl. 4, figs. 28-36, 1856 ; Forti in De Toni, Syll. Alg. 5 : 94, 1907. *Anacystis cyanea* (Kütz.) Drout & Daily, Rev. Coccoid Myxophy. 36, 1956, pro parte, incl. var. *major* (Wittr.) Smith, et al. vars. & formis *M. aeruginosae.*

Cell diameter=3.8-5.7 μ.

Habitat : Forming a dirty green scum on the surface of quiet stagnant water of permanent and semi-permanent ponds, Hoshiarpur.

GLOEOTHECE Näg.

2. **Gloeothece rupestris** (Lyngb.) Bornet in Mem. Soc. Sci. Nat. Math. Cherbourg 28 : 177, 1892 ; Forti 5 : 63, 1907 ; Frémy 52, fig. 61, 1929 ; Geitler 221, 1932.

Lat. cell without envelope=3.6-6 μ, lat. cell with envelope=7.6-13.6 μ ; long. cell=6.8-15.3 μ ; diam. colony=23-42.5 μ.

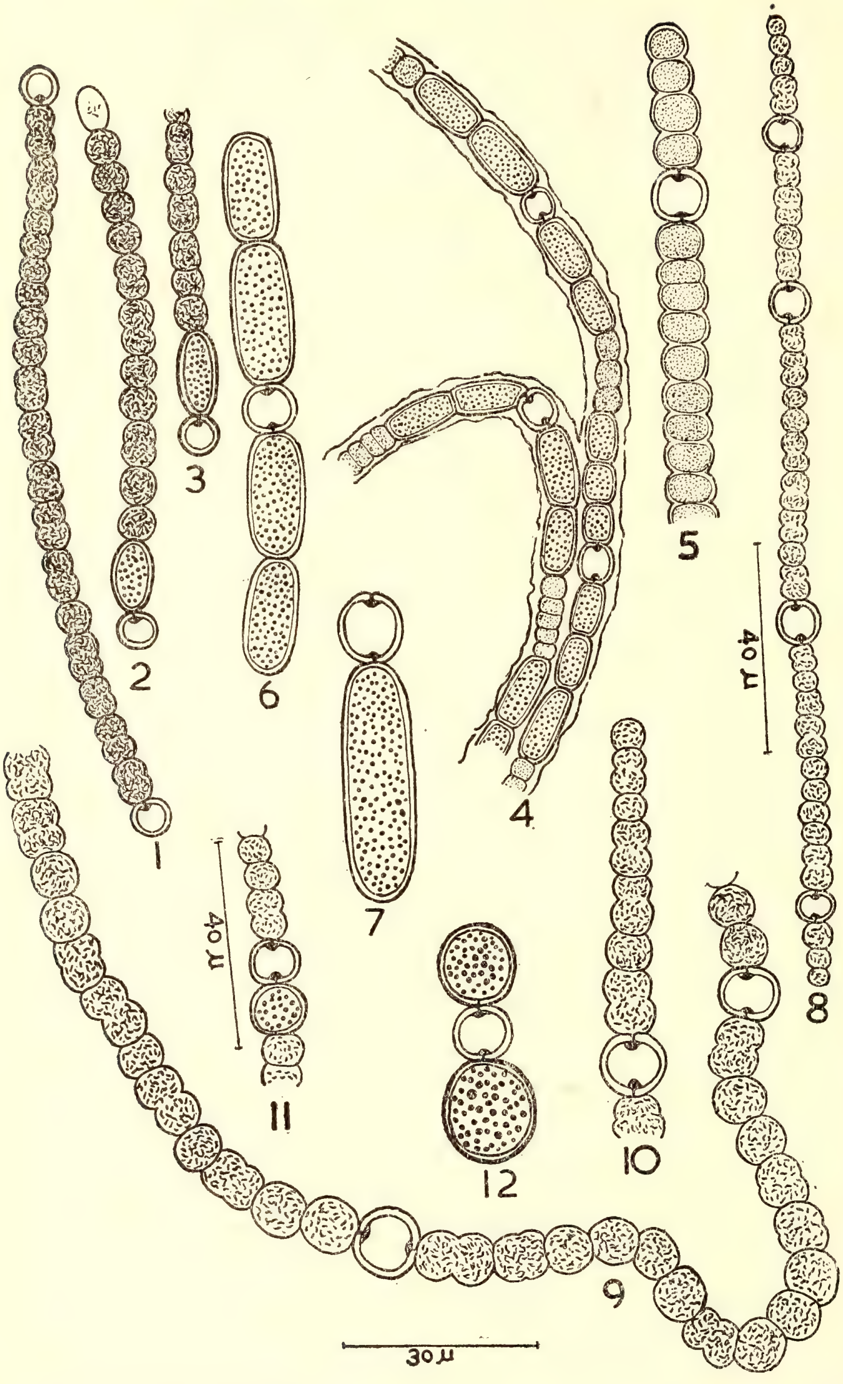
Habitat : On moist soil, Hoshiarpur.

APHANOTHECE Näg.

3. **Aphanothece microscopica** Näg. Gatt. Einzell. Algen 59, pl. 1 H, 1849 ; Forti 5 : 83, 1907 ; Frémy 28, fig. 30, 1929 ; Geitler 172, fig. 79, 1932.

Lat. cell=4-5.1 μ ; long. cell=6.1-8.5 μ.

Habitat : Free-floating in a permanent pond at village Nasrala, Hoshiarpur.



Cylindrospermum distinctum sp. nov.: Fig. 1. Trichome with two terminal heterocysts one at each end; Figs. 2 & 3. Trichomes with akinetes. *Anabaena vaginicola* Fritsch et Rich.: Fig. 4. A filament with two trichomes. *Anabaena oscillarioides* var. *crassa* var. nov.: Fig. 5. A portion of the trichome with end cell; Figs. 6 & 7. Sporiferous portions of the trichome. *Anabaena mehrai* sp. nov.: Fig. 8. A young trichome with attenuated ends; Fig. 9. Portion of an irregularly curved trichome; Fig. 10. Portion of a trichome with rounded end cell; Fig. 11. Part of a trichome showing only one spore situated one side of the heterocyst; Fig. 12. Portion of a sporiferous trichome showing one spore on either side of the heterocyst.

Order NOSTOCALES Geitler

Family NOSTOCACEAE Kützing

Subfamily ANABAENOIDEAE Born. et Flah.

CYLINDROSPERMUM Kützing

4. **Cylindrospermum alatosporum** Fritsch in Ann. South Afr. Mus. 9 : 587, fig. 37, d, h, 1918 ; Geitler 817, fig. 521, 1932.

Lat. cell=3.4-4.2 μ ; long. cell=3.4-5.1 μ ; lat. heterocyst=5.1-5.9 μ, long. heterocyst=5.9-8.5 μ ; lat. spore with outer wall=8.5-11.9 μ, long. spore=20.4-28.9 μ.

Habitat : Forming dark blue-green mucilaginous growth on moist soil by the side of a water-course at village Purhiran, Hoshiarpur.

5. **Cylindrospermum musicola** Kütz. ex Born. et Flah. in Kützing, Phyc. Germ. 173, 1845 ; Tab. Phycol. 1 : 53, pl. 98, fig. 1, 1849 ; Bornet et Flahault, Rev. Nostoc. Hétéroc. 254, 1888 ; Forti 5 : 477, 1907 ; Frémy 376, fig. 313, 1929 ; Geitler 822, fig. 520 d, 1932.

var. **longispora** Dixit in Proc. Indian Acad. Sci. B 3 : 100, fig. 3 A, B, 1936.

Lat. cell=3-4 μ ; long. cell=3.8-7.6 μ ; lat. heterocyst=4.7-5.7 μ ; long. heterocyst=5.7-9.6 μ ; lat. spore=5.7-11.5 μ ; long. spore=13.1-30.6 μ.

Habitat : In stagnant water of a roadside ditch ; on moist soil, Hoshiarpur.

6. **Cylindrospermum distinctum** sp. nov. (Figs. 1-3).

Trichomes single, straight, rarely curved, blue-green, with distinct constrictions at the septa ; cells spherical to barrel-shaped, as long as broad, pseudovacuoles present ; heterocysts spherical ; akinetes ellipsoidal, always present contiguous to the heterocysts, outer wall hyaline.

Trichomata singula, recta, raro curvata, caeruleo-viridia, constricta ad septa ; cellulae sphaericae vel doliiformes, aeque longae ac latae, pseudovacuola adsunt ; heterocysta sphaerica ; akinetes ellipsoidei, semper adsunt contigui heterocystis ; parietibus exterioribus hyalinis. Typus positus in P. U. College, Hoshiarpur, sub numero *Vasishta* 4328.

Lat. trichome=3.7-5.7 μ ; long. cell=3.7-5.7 μ ; diameter heterocyst=7.5 μ ; lat. spore=7.5-10.5 μ ; long. spore=11.2-16.7 μ.

Habitat : Free-floating in the stagnant water of a pond, Phagwara Road, Hoshiarpur, 25.2.60.

This species comes close to *Cylindrospermum indicum* Rao in possessing (a) free-floating trichomes that occur singly, and (b) ellipsoidal spores ; but differs in (a) the shape and dimensions of cells, (b) presence of pseudovacuoles in the cells, (c) broader heterocysts, and (d) spores without a special outer membrane and smaller in dimensions.

This species stands distinct from all the existing species of the genus in possessing free-floating trichomes that occur singly and do not form a plant mass or thallus and in possessing cells that are packed with pseudovacuoles.

The type specimen is deposited (in the form of camera lucida drawings) in the herbarium of Punjab University College, Hoshiarpur, *Vasishta* 4328.

NOSTOC Vaucher

7. **Nostoc punctiforme** (Kütz.) Hariot, Journ. Bot. 5 : 31, 1891 ; Forti 388, 1907 ; Frémy 331, fig. 274, 1929 ; Geitler 834, 1932. *Nostoc hederulae* Meneghini in Kützing, Sp. Alg. 287, 1849 ; Born. et Flah., op. cit. 189, 1888.

Lat. cell=3-4 μ ; long. cell=3-6 μ ; diameter heterocyst=4.5-6 μ ; lat. spore=4.6-6.5 μ ; long. spore=4.6-8 μ.

Habitat : In culture of crop field soil from village Purhiran, Hoshiarpur.

8. **Nostoc linckia** (Roth.) Bornet ex Born. et Flah. in Bornet et Thuret, Not. Algol. II, 86, pl. 18, figs. 1-12, 1880 ; Born. et Flah. 192, 1888 ; Frémy 332, fig. 276, 1929 ; Geitler 838, fig. 5286, 1932.

Lat. cell=3.8-5.7 μ ; long. cell=3.8-5.7 μ ; diameter heterocyst=7.6 μ ; lat. spore=6-7.6 μ ; long. spore=7.6-8 μ.

Habitat : On the sides of a *pukka* drain, District Board, Hoshiarpur.

9. **Nostoc verrucosum** Vaucher ex Born. et Flah. in Vaucher, Hist. Conf. Eau Douce 225, pl. 16, fig. 3, 1803 ; Born. et Flah. 216, 1888 ; Forti 5 : 419, 1907 ; Frémy 350, fig. 290, 1929 ; Geitler 854, figs, 43, 542 et 543, 1932.

Lat. cell=3.8-4 μ ; long. cell=3-3.8 μ ; lat. heterocyst=5.7-7.6 μ ; long. heterocyst=6-8.5 μ ; lat. spore=4.7-5.7 μ ; long. spore=5.7-7.6 μ.

Habitat : On the rocky bed of a stream at Bharwain, Hoshiarpur.

10. **Nostoc ellipsosporum** (Desm.) Rabenh., Fl. Eur. Alg. 2 : 169, 1865 ; Bornet et Thuret 2 : 94, pl. 27, figs. 7-11, 1880 ; Born. et Flah. 198, 1888 ; Geitler 841, fig. 533, 1932.

Lat. cell=3.8-4 μ ; long. cell=4-11.5 μ ; lat. heterocyst=4-7.6 μ ; long. heterocyst=7.6-11.5 μ ; lat. spore=5.7-7.6 μ ; long. spore=8.5-12 μ.

Habitat : On the moist soil of a crop field ; in stagnant water of a roadside ditch, Hoshiarpur.

ANABAENA Bory

11. **Anabaena vaginicola** Fritsch et Rich. in Trans. Roy. Soc. S. Afr. 18 : 87, 1929. *Anabaenothrix vaginicola* (Fritsch et Rich.) Ghose et Randhawa in Proc. Indian Acad. Sci. B 3 : 407, 1936. (Fig. 4).

Trichomes single or many in a common mucilaginous sheath, more or less parallel, attached to other plants ; sheath diffluent, colourless, with a rough outline ; trichomes straight or slightly bent, shining blue-green, constricted at the joints ; cells sub-quadrate, sometimes cylindrical, contents blue-green and granular ; apical cell conical with pointed apex; heterocysts cylindrical or barrel-shaped, slightly flattened at the apices, sometimes become crushed by the pressure of the developing spores, occurring at irregular intervals ; spores short cylindrical or oblong, ends flattened or rounded, contiguous with the heterocysts, often two to four in series, wall hyaline, smooth.

Lat. filament with one trichome=7.5-11.2 μ ; lat. filament with two trichomes=15 μ ; filament with more than two trichomes up to 21 μ broad; lat. trichome=4-5.6 μ ; long. cell=3.7-4.6 μ ; lat. heterocyst=4.6-5.6 μ ; long. heterocyst=4.6-8 μ ; lat. spore=7.5-11.2 μ ; long. spore =7.5-18.5 μ.

Habitat : Attached to submerged plants in a roadside pond, Phagwara Road, Hoshiarpur.

12. **Anabaena iyengarii** Bharad. in Proc. Indian Acad. Sci. B 2 : 105, fig. 6 H-K, 1935. var. **tenuis** Rao in Proc. Indian Acad. Sci. B 6 : 361, fig. 5 A-C, 1937 b.

Lat. cell=3.7-4.6 μ ; long. cell=3.7-7.5 μ ; lat. heterocyst=4.6-7.5μ ; long. heterocyst=6.6-7.5 μ ; lat. spore=6.6-11.2 μ ; long. spore=10.5-22.5 μ.

Habitat : In a pond on Phagwara Road, Hoshiarpur.

13. **Anabaena oscillarioides** Bory in Born. et Flah. 233, 1888 ; Geitler 886, fig. 567 e, 1932.

var. **crassa** var. nov. (Figs. 5-7).

Plant mass soft, mucilaginous, blue-green ; trichomes straight, or curved, constricted at septa, blue-green ; end cell with rounded apices ; cells barrel-shaped, as long as broad or slightly shorter or longer than broad, contents granular ; heterocysts spherical, rarely slightly barrel-shaped, intercalary ; akinete on both sides of the heterocyst, single or in series, cylindrical.

Planta mollis, mucilaginosa, caeruleo-viridis ; trichomata recta vel curvata, constricta ad septa, caeruleo-viridia ; cellulae terminales apicibus rotundatis ornatae ; cellulae doliiformes, aeque longae ac latae, vel paulo breviores vel longiores, contentis granularibus ; heterocysta sphaerica, raro paulo doliiformia, intercalaria ; akinetes efformati ad utrumgue latus heterocysti, singuli vel seriati, cylindrici. Typus positus in P.U. College, Hoshiarpur, sub numero *Vasishta* 1.

Lat. trichome=5.6-7.5 μ (usually 6.6 μ); long. cell=3.7-8 μ; lat. heterocyst=7.5-11.2 μ; long. heterocyst=7.5-11.2 μ; lat. spore=7.5-11.2 μ; long. spore=15-33.7 μ (rarely 37.4 μ).

Habitat: In the stagnant water of a roadside pond, Phagwara Road, Hoshiarpur, 15-1-1960.

This variety resembles the type in possessing (a) trichomes with rounded end cells, (b) shape of cells and heterocysts, (c) shape of spores, and (d) spores are up to three or three and half times as long as broad; but differs in possessing (a) broader cells, (b) broader heterocysts, and (c) broader spores.

This variety differs from var. *angustus* Bharadwaja in possessing (a) broader trichomes and broader heterocysts, (b) heterocysts spherical and not ellipsoidal, and (c) broader spores that are smaller in length and are not surrounded by any special mucilaginous sheath.

The type of the variety is deposited in the herbarium of Panjab University College, Herbarium, *Vasishta* 1.

14. **Anabaena mehrai** sp. nov. (Figs. 8-12).

Trichome single, curved or straight, mucilaginous sheath absent, constricted at the joints; end cell with rounded apices; cells spherical or slightly barrel-shaped, as long as broad, or slightly shorter than broad, contents blue-green, pseudovacuoles present; heterocysts intercalary, spherical; akinetes usually spherical, rarely oval, always contiguous to the heterocysts, outer wall yellow-brown in colour.

Trichomata singularia, curvata vel recta, vagina mucilaginosa nulla, constricta ad septa; cellulae terminales apicibus rotundatis ornatae; cellulae sphaericae vel tenuiter doliiformes, aeque longae ac latae vel paulo breviores, contentis caeruleo-viridibus, pseudovacuola adsunt; heterocysta intercalaria, sphaerica; akinetes vulgo sphaerici raro ovati, semper contigui heterocystis, parietibus exterioribus luteo-brunneis. Typus positus in P.U. College, Hoshiarpur, sub numero *Vasishta* 4329.

Lat. cell=6.5-8 μ; long. cell=5.6-7.5 μ; lat. cell at the apex=5.1 μ; diameter heterocyst=7.5-11.2 μ; diameter spore=9.3-15 μ.

Habitat: Planktonic in a roadside pond, Phagwara Road, Hoshiarpur, 29-9-1958.

The present species resembles *Anabaena spiroides* Klebhan and *A. werneri* Brünn in possessing pseudovacuoles in the cells, but differs from the former in not possessing spirally coiled trichomes, in the absence of a broad mucilage sheath around the trichomes, in broader heterocysts and in the spores being always contiguous to the heterocyst. It differs from *A. werneri* in that the akinetes are not variable in position but are always present next to the heterocyst. The present species also differs from *A. planktonica* Brünn in not possessing a broad mucilage sheath around the trichomes and in the greater diameter of the cells and heterocysts. This form approaches *A. sphaerica*, *A. fertilissima*, *A. gelatinicola*, *A. anomala*, and *A. randhawae* in possessing spherical heterocysts but differs from all these species in possessing pseudovacuoles in the cells and from individual species in several respects.

The present form may, therefore, be regarded as a new species of *Anabaena* and the author takes great pleasure in naming it after Dr. P. N. Mehra, D.SC., F.N.I., Professor of Botany, Panjab University, and one of the distinguished botanists of India.

The type specimen is deposited (in the form of camera lucida drawings) in the herbarium of Panjab University College, Hoshiarpur, *Vasishta* 4329.

Subfamily AULOSIRAE Born. et Flah.

AULOSIRA Kirchner

15. **Aulosira prolifica** Bharadwaja in Ann. Bot. Lond. 47 : 131, figs. 5, 6, 1933 a.

Lat. filam.=5-7.5 μ; crass. vag. outer=1.87 μ, crass. vag. inner=1 μ; lat. cell=3.4-4.5 μ; long. cell=6-15 μ (rarely 22.2 μ); lat. heterocyst =4.5-8 μ; long. heterocyst=7.5-12 (-18) μ.

Habitat : Forming a blue-green to pale-brownish scum floating on the surface of stagnant water of a semi-permanent pond, Phagwara Road, Hoshiarpur.

The filaments in the Hoshiarpur alga are broader than the type.

NODULARIA Mertens

16. **Nodularia spumigena** Mertens ex Bornet et Flahault in Rev. Nostoc. Héteroc. 245, 1888 ; Geitler 866, fig. 554 b, c, 1932.

Lat. filament=8.5-11.9 μ; lat. trichome=8-10.2 μ; long. cell=3.7 μ; lat. heterocyst=9.5-12.5 μ; long. heterocyst=5.8-8 μ; lat. spore=11-11.25 μ; long. spore=7.5-8.5 μ.

Habitat : In a semi-permanent pond on Phagwara Road, Hoshiarpur. It occurs mixed with other algae.

In specimens collected from Hoshiarpur, occasional occurrence of terminal heterocysts has been noticed. The filaments are usually curved and even coiled in an irregular manner. It has also been observed that two daughter cells of a recently divided cell become converted into two terminal heterocysts which break apart resulting in the formation of two filaments each with a terminal heterocyst.

Family OSCILLATORIACEAE Kirchner

OSCILLATORIA Vaucher

17. **Oscillatoria subbrevis** Schmidle in Bot. Jahrb. 30 : 243, pl. 4, fig. 7, 1901 ; Geitler 949, fig. 601 b, 1932.

Lat. trichome=6.8-8.5 μ ; long. cell=1.7-2.5 μ.

Habitat : On moist soil, Hoshiarpur.

18. **Oscillatoria chlorina** Kütz. ex Gomont, Mon. Oscill. 233, 1892 ; Geitler 951, fig. 611 c, 1932. *Oscillatoria tenuis* Ag. var. *chlorina* (Kütz.) Playf. Biol. Richmond River 132, pl. 6, fig. 10, 1914.

Lat. trichome=3.4-4.2 μ ; long. cell=3.4-8.5 μ.

Habitat : On moist soil ; in stagnant water of a temporary pond, Hoshiarpur.

19. **Oscillatoria claricentrosa** Gardner in Mem. N.Y. Bot. Gard. 7 : 37, pl. 8, fig. 72, 1927 ; Geitler 971, fig. 615 c, 1932.

forma **bigranulata** Rao in Proc. Indian Acad. Sci. B 6 : 367, fig. 7 c, 1937 b.

Lat. trichome=2-3 μ ; long. cell=4-10 μ.

Habitat : Sides of a water tank, Panjab University College, Hoshiarpur.

LYNGBYA Ag.

20. **Lyngbya spiralis** Geitler, Kryptog. 1042, fig. 659, 1932.

Lat. filament=5.1-6.8 μ ; lat. trichome=4.5-5.1 μ ; long. cell=1.7-2.5 μ ; crass. vag.=0.3-0.8 μ.

Habitat : Along with other algae in a permanent pond near railway crossing at village Nasrala, Hoshiarpur.

21. **Lyngbya martensiana** Menegh. ex Gomont, Mon. Oscill. 145, fig. 17, pl. 3, 1892 ; Geitler 1064, fig. 676, 1932.

Lat. filament=13.4-15.3 μ ; lat. trichome=10.2-11.5 μ long. cell=2.5-3.4 μ ; crass. vag.=1.7 μ.

Habitat : In a roadside pond, Phagwara Road, Hoshiarpur.

22. **Lyngbya allorgei** Frémy 189, fig. 156, 1929 ; Geitler 1059, fig. 671, 1932.

Lat. filament=5.1-5.9 μ ; crass. vag.=0.85 μ ; lat. trichome=3.4-4.2 μ ; long. cell=5.1-5.9 μ.

Habitat : On moist soil in flower pots, mixed with *Hormidium flaccidum*, Panjab University College, Hoshiarpur.

23. **Lyngbya gardneri** Geitler 1037, 1932. *L. erecta* Setchell et Gardner in Proc. Acad. Sci., 4th ser., 122, 1930, (non *L. erecta* Setchell et Gardner, 1927).

Lat. filament=1.7-2.5 μ; lat. trichome=1.3-1.7 μ; long. cell=3.4-6.8 μ; long. filament=1-2 mm.

Habitat : On soil at the bottom of a pond at Hoshiarpur.

It forms yellowish green masses attached to the soil at the bottom of ponds. The basal cell becomes slightly flattened at its lower end and serves as an attaching organ.

24. **Lyngbya perelegans** Lemm. in Abh. nat. ver. Bremen 16 : 355, 1899, et 18 : 153, pl. 11, figs. 13-14, 1904 ; Kryptog. Mark Brand. 3 : 138, 1910 ; Geitler 1056, fig. 66 a-c, 1932.

Lat. filament=1.7-2.5 μ; lat. trichome=1.5-2 μ; long. cell=2.5-3.4 μ. A single granule is present on either side of the septa.

Habitat : On the bottom mud of a pond at Hoshiarpur.

25. **Lyngbya palmarum** (Mertens) Brühl et Biswas in Jour. Dept. Sci. Calcutta Univ. 11, pl. 4, fig. 14, 1923. *Scytonema palmarum* Martens in Proc. Asiatic Soc. Bengal 39 : 11, 1870.

Lat. filament=7.6-8.5 μ; lat. trichome=6.8 μ; long. cell=5.1-8.5 μ, crass. vag.=0.85-1 μ.

Habitat : On the bark of a palm tree in Panjab University College, Hoshiarpur.

It forms dark-coloured extensive and densely tomentose thallus on the trunks of palm trees. During dry months the thallus becomes pale green to pale yellow.

SYNOPSIS

A detailed account of the ecology and systematics of some of the blue-green algae of district Hoshiarpur has been given in this paper. This district affords unique opportunities of algal collections from aquatic, sub-aerial, and aerial habitats, and has been correctly noted by Dr. M. S. Randhawa as an ' algologist's paradise '.

ACKNOWLEDGEMENTS

The present work has been carried out in the Department of Botany, Panjab University College, Hoshiarpur, and the author is grateful to Prof. Hukam Chand Nabh, Head of the Botany Department, for giving him all the available facilities. To Shri B. R. Vasishta, Head of the Botany Department, M. M. Degree College, Modinagar, the author is grateful for going through the manuscript and suggesting useful changes.

The Genus *Veronica* Linn. of Eastern India

BY

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(*With a plate*)

The genus *Veronica* of the family Scrophulariaceae has altogether 250 species, which are mostly distributed in the temperate countries of the world and are sometimes alpine. Of these, 35 species are found in India, out of which only 18 species were described by Hooker in his FLORA OF BRITISH INDIA 4 (1885), and the remaining 17 species were later reported by Pennell.

Only 9 species are found in this part of India, and are mostly distributed on the hills of Assam, Sikkim, and Bhutan. In the present paper, these 9 species, viz. *V. capitata* Royle ex Benth., *V. lanuginosa* Benth. ex Hook., *V. ciliata* Fisch., *V. javanica* Blume, *V. cana* Wall., *V. anagallis* Linn., *V. deltigera* Wall., *V. himalensis* D. Don, and *V. hederaefolia* Linn. are described and a specific key is given for their easy identification. The species *V. hederaefolia* Linn., which was previously reported from Kashmir, has been discovered in Sikkim.

Another variety, *V. anagallis* Linn. var. *montioides* Boiss., is also described here. This variety, reported formerly from W. Tibet and Afghanistan, has been found further east in the Sangpo-Valley on the Assam-Tibet frontier.

This work is part of a study on Scrophulariaceae of eastern India which the author is carrying on at present. In connection with the present study he received a grant for field work from the Bombay Natural History Society, from funds made available by the Rockefeller Foundation. He takes this opportunity to express his sincere thanks to the authorities for this generous help.

Veronica Linn. Sp. Pl. 9, 1753.

Perennial or annual herbs, shrubs or rarely trees. *Leaves* simple, opposite, rarely upper alternate, exstipulate. *Inflorescence* racemose or solitary. *Flowers* pedicellate or sessile, bisexual, complete, irregular, hypogynous, usually bracteate, white, blue or purple. *Calyx* 4-5-partite, united at the base, imbricate. *Corolla* 4-5-partite, gamopetalous, rotate or salver-shaped ; lobes unequal, obtuse, entire ; lateral broader, outer in bud ; imbricate. *Stamens* 2, epipetalous, attached to the upper lobe, exserted, anther-cells parallel or divergent. *Ovary* : carpels 2, syncarpous, 2-celled, superior ; style filiform ; stigma subcapitate or bilobed ; ovules many in each cell ; placentation axile. *Fruit* a capsule, compressed or turgid, 2-grooved. *Seeds* many or few, various in shape, sometimes winged.

Key to Species

A. Flowers in racemes
B. Flowers sessile or subsessile
C. Capsule broadly obcordate, laterally flattened .. .. .. *capitata*
CC. Capsule ovoid or oblong, slightly laterally compressed
D. Leaves orbicular or broadly ovate, woolly, very close and covering the stem .. .. .. *lanuginosa*
DD. Leaves ovate or oblong, pubescent, not close and covering the stem .. .. .. *ciliata*
BB. Flowers pedicellate
C. Leaves petiolate
D. Annual. Capsule broadly obcordate.. *javanica*
DD. Perennial. Capsule truncated .. *cana*
CC. Leaves usually sessile
D. Stem succulent .. .. *anagallis*
DD. Stem not succulent
E. Leaves usually 1-4 cm. long. Inflorescence short-peduncled .. *deltigera*
EE. Leaves usually 4-9 cm. long. Inflorescence long-peduncled *himalensis*
AA. Flowers solitary .. .. .. *hederaefolia*

1. **Veronica capitata** Royle ex Benth. Scroph. Ind. 45, 1835.

Herb. *Stem* short, suberect, pubescent. *Leaves* sessile or shortly petiolate, opposite, largest pair often uppermost, ovate or shortly oblong, obtuse or acute, crenate-serrate or subentire, usually pubescent, rarely glabrous, base rounded, 1-4 cm. long, 0.8-2 cm. wide. *Inflorescence* terminal, villous, in umbels or heads. *Flowers* sessile or subsessile, white or blue, small. *Calyx* : sepals 4-5, gamosepalous, spathulate-oblong, obtuse, 0.3 cm. long. *Corolla* : petals 4-5, gamopetalous, white-blue, 0.5 cm. long. *Stamens* 2 ; filaments filiform. *Ovary* ciliate ; style simple, stigma bilobed. *Fruit* a capsule, ciliate, broadly obcordate, 0.4 cm. in diameter. *Seeds* elliptic, flattened.

Koteh-ya-my (4650 m.), Aug. 1888, *Dr. King's collector* ; Pey-King-la, July 1887, *Dr. King's collector* ; Tumbok (3700 m.), 10th Oct. 1870, No. 12915D ; Teesta Valley above Tangu (4080 m.), 6th July 1903, *F. E. Younghusband* ; Kambajong, Sept. 1903, *D. Prain* ; Yakla (4330 m.), 18th Oct. *C. B. Clarke* 10142 ; Mt. Singhulalah (3700 m.), 3rd June 1892, *G. A. Gammie* 61 ; Teumtong (3400 m.), May 1885, *Dr. King's collector.*

2. **Veronica lanuginosa** Benth. ex Hook. f. Fl. Brit. Ind. 4 : 293, 1885.

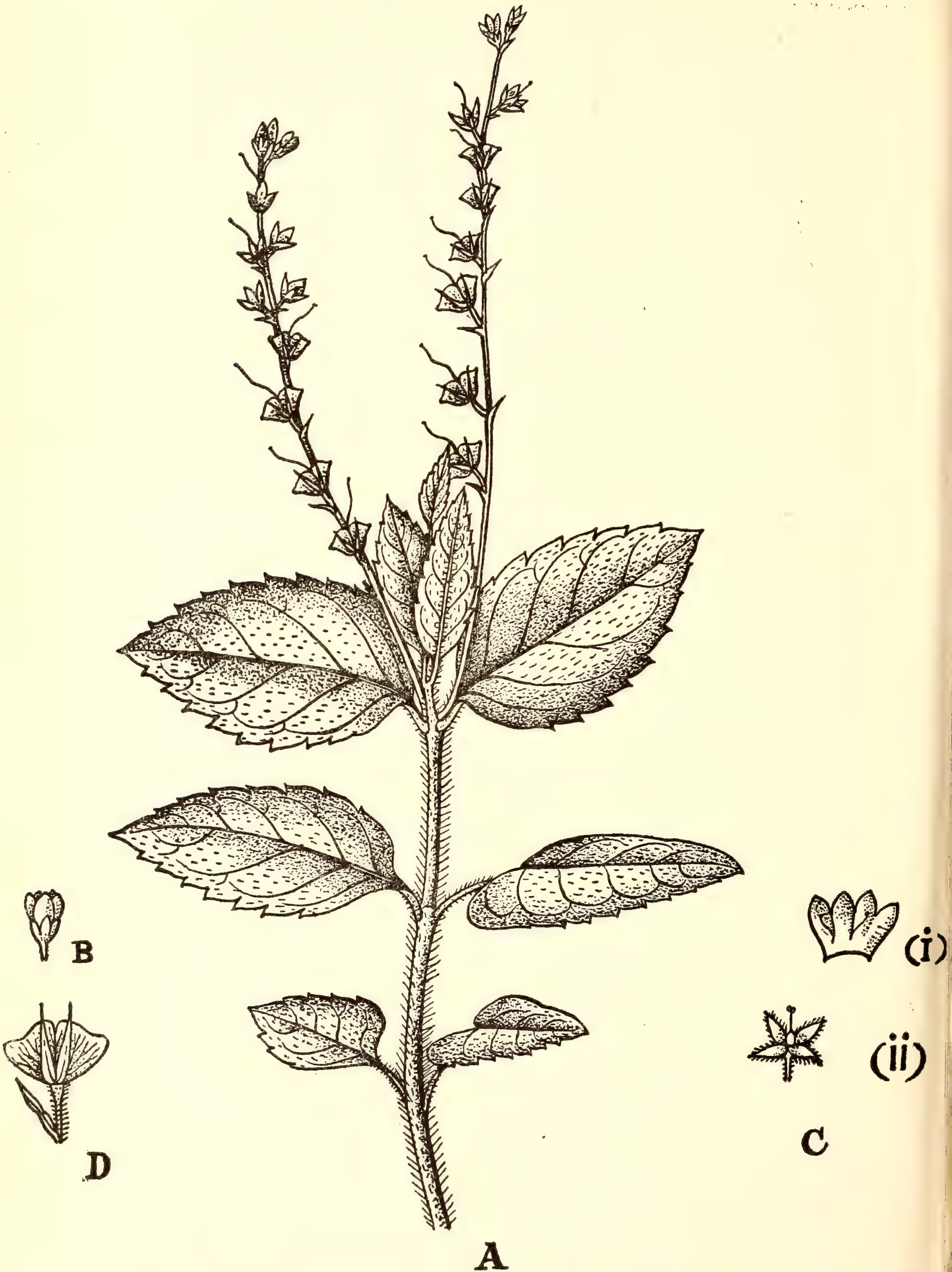
Herb. *Stem* densely woolly, 5-7 cm. long. *Leaves* sessile, opposite, orbicular or upper broadly ovate, obtuse or subacute, entire, woolly, very close and covering the stem, 0.4-1.2 cm. long, 0.4-1.2 cm. wide. *Inflorescence* terminal, in woolly heads. *Flowers* sessile, small, bracteate, deep blue in colour. *Calyx* : sepals 4, gamosepalous, oblong, subacute, 0.3 cm. long, persistent. *Corolla* : petals 4, gamopetalous, spathulate, upper orbicular, larger and broader than the others, ± 0.6 cm. long. *Stamens* 2 ; filaments short. *Ovary* elliptic ; style ± 0.4 cm. long ; stigma bilobed. *Fruit* a capsule, elliptic notched, pubescent, equalling the sepals. *Seeds* plano-convex, oblong.

Rangsa, Llovok (4800 m.) 28th July 1909, *Smith & Cave* 2023 ; Nakula, 28th July 1903, *F. E. Younghusband* 223 ; Thang Chung la (4900 m.), 15th July 1909, *Smith & Cave* 1476.

3. **Veronica ciliata** Fisch. in Mem. Soc. Nat. Mosc. 3 : 56, 1812. *V. alpina* George, Reise 1 : 195, 1775. *V. macrocarpa* Turez. ex Steud. Nom. (ed. 2) 2 : 758, 1841. *Bartsia mollis* Turez. ex Herd. in Bull. Soc. Nat. Mosc. 58 : 1. 397, 1883.

Erect herb. *Stem* stiff, hoary-pubescent, 10-30 cm. long. *Leaves* sessile, opposite, ovate or oblong, obtuse or acute entire, serrate or crenulate, pubescent, 0.8-4 cm. long, 0.5-1.5 cm. wide. *Inflorescence* of terminal hirsute heads. *Flowers* sessile, bracteate ; bracts equalling the calyx. *Calyx* : sepals 4, gamosepalous, oblong, obtuse, pubescent, ± 0.5 cm. long. *Corolla* : petals 4-5, gamopetalous, small, broad, reddish blue, ± 0.6 cm. long. *Stamens* 2, included ; anther cells 2, parallel, obtuse. *Ovary* ovoid ; style filiform ; stigma bilobed. *Fruit* a capsule, ovoid-oblong, notched. *Seeds* orbicular, plano-convex, compressed.

Thangu (4270 m.), Sept. 1909, *Lepcha collector* 2914 ; Sikkim (3400-4270 m.), *J. D. Hooker* ; Llovok (4420 m.), 1st Aug. 1909, *Smith & Cave* 1841 ; Nakuchu (4950 m.), 4th Aug. 1909, *Smith & Cave* 1994 ; Lungma chu (4950 m.), 6th Aug. 1909, *Smith & Cave* 2239 ; Naku La, 29th July 1903, *F. E. Younghusband* 232 ; Momay Samdong, Lachung (4950 m.), 17th Aug. 1892, *G. A. Gammie* 851 ; Kung-met, 3rd Aug. 1884, *Dungboo* 301.



A. *Veronica cana* Wall. var. *robusta* × 1; B. Flower × 1½; C. Flower dissected open: (i) Corolla with epipetalous stamens × 2; (ii) Pistil with calyx × 2; D. Fruit with bract × 2½.

4. **Veronica javanica** Blume, Bijd. 742, 1826. *V. maddeni* Edgew. ex Hook. f. Fl. Brit. Ind. 4 : 296, 1885.

Annual herb. *Stem* much branched, spreading from the root, ascending, 15-45 cm. long, pubescent. *Leaves* petiolate, petiole 0.3-0.8 cm. long, rarely sessile, ovate, sub-cordate or truncate, obtuse, crenate-serrate, base rounded, pubescent. *Inflorescence* in axillary racemes. *Flowers* pedicellate (pedicels ± 3 mm. long), blue or white, 5 mm. in diameter, bracteate ; bracts longer than pedicels. *Calyx* : sepals 4, linear-oblong, obtuse, ± 3 mm. long. *Corolla* : petals 4, ± 5 mm. long. *Stamens* 2 ; anthers basifixed. *Ovary* pubescent. *Fruit* a capsule, cordate, narrowed to the base, 3 mm. in diameter. *Seeds* elliptic, biconvex.

Great Nanget Valley, *S. Kurz* ; Banquet Valley (1525 m.), May 1862, *T. Anderson* 272A ; Phedong (900 m.), 13th May 1876, *C. B. Clarke* 27918B ; Shillong (1525 m.), 16th May 1885, *C. B. Clarke* 38184E ; Dibrooghur (900 m.), 5th April 1885, *C. B. Clarke* 37741A ; Talap-Lakhmipur, 23rd March 1894, *G. A. Gammie* 188 ; Kabo, 10th March 1912, *I. H. Burkill* 36796 ; Dumpep-Khasia hills (1925 m.), 30th May 1911, *I. H. Burkill & S. C. Banerjee* 34250.

5. **Veronica cana** Wall. [Cat. 401 1828] ex Benth. Scroph. Ind. 45, 1835; DC. Prodr. 10 : 475, 1846 ; Fl. Brit. Ind. 4 : 295, 1885.

Perennial herb. *Stem* 15-30 cm. long, ascending, usually slender, pubescent, villous or glabrous. *Leaves* petiolate (petioles 0.2-1.5 cm. long) opposite, ovate or ovate-cordate, obtuse or sub-acute, crenate or serrate, pubescent or glabrous, 1-4 cm. long, 0.7-2.4 cm. wide. *Inflorescence* a raceme, axillary or terminal. *Flowers* pedicellate (pedicels equalling or shorter than the calyx), bracteate ; bracts small, linear, shorter than the calyx. *Calyx* : sepals 4, united just at the base, unequal, linear-oblong, obtuse, ± 3 mm. long. *Corolla* : petals 4, gamopetalous, lateral outer in bud, upper and lower usually narrowest, ± 5 mm. long, imbricate, white or blue. *Stamens* exserted ; filaments filiform, ± 3 mm. long ; anthers cordate, obtuse, less than 0.5 mm. long, basifixed. *Ovary* oval ; style filiform, ± 2-8 mm. long, persistent. *Fruit* a capsule, truncate, glabrous or ciliate, ± 6 mm. in diameter. *Seeds* flat, ovate-oblong, thin.

Lachumy, July 1879, *King's collector* ; Bhutan (1500 m.), 1st June 1906, *J. C. White* ; Zemu valley (3340 m.), 10th July 1909, *Smith & Cave* 416 ; Lamtang to Tangu (3070 m.), 1st July 1909, *F. E. Younghusband* T 23 ; Buckeem (2400 m.), 12th Oct. 1875, *C. B. Clarke* 2529, 25293A ; Tongir (4000 m.), 15th Oct. 1875, *C. B. Clarke* 25835 C ; Tankra Mt. (3070 m.), 5th August 1892, *G. A. Gammie* 622 ; Latong swamps (2150 m.), May 1885, *King's collector* ; Sikkim, *R. Seshagiri Rao* 595.

(*a*) **Veronica cana** Wall. var. **robusta** Prain in Journ. As. Soc. Bengal 20 : 20, 1903. (see Plate)

This variety differs from *V. cana* proper in the following points : (i) robust habit, (ii) denser tomentum, (iii) larger leaves, (iv) sepals lanceolate and acute, and (v) anthers hastate and larger.

Perennial herb. *Stem* erect, robust, up to 50 cm. long, tomentose or hispid. *Leaves* petiolate (petioles 1-2 cm. long), opposite, ovate or ovate-oblong, sub-acute, serrate, tomentose, 3-5.5 cm. long, 1.5-3.3 cm. wide. *Inflorescence* a raceme, axillary or terminal. *Flowers* pedicellate, bracteate, bracts equalling the calyx. *Calyx* : sepals 4, united at the base, lanceolate, acute, hairy, 4 mm. long. *Corolla* : petals 4, gamopetalous, imbricate, 5 mm. long. *Stamens* epipetalous ; filaments filiform, ± 3 mm. long ; anthers hastate, basifixed, ± 1 mm. long. *Ovary* 2-celled ; style terminal, ± 2-10 mm. long, persistent ; stigma bilobed. *Fruit* a capsule, truncate. *Seeds* ± 1 mm. long, flat, ovate-oblong, thin with two dark swelling points, one at the centre and another at the base.

Tangloo (300 m.), Aug. 1887, *King's collector*, Lectotype in Herb. Cal. ; Sikkim, 15th Oct. 1868, *S. Kurz* ; Kallipola, June 1887, *King's collector* ; Kallipokri, June 1887, *King's collector* ; North of Tonglu (2800 m.), 19th May 1909, *I. H. Burkill* 32007.

6. **Veronica anagallis** Linn. Sp. Pl. 12, 1753 ; Benth. in DC. Prodr. 10 : 467, 1846 ; Reichle, Ic. Fl. Germ. t. 1762, 1862 ; Boiss. Fl. Orient. 4: 473, 1879 ; Fl. Brit. Ind. 4 : 293, 1885 ; Beng. Pl. 2 : 773, 1903. *V. acutifolia* Gilib. Exercit. 1 : 119, 1792. *V. aquatica* S. F. Gray, Wat. Arr. Brit. Pl. 2 : 306, 1821. *V. ambigua* Luce, Topog. Nachr. Oesel 4, 1823. *V. undulata* Wall. Cat. 406, 1828. *Cordia amplexicaulis* Dulac, Fl. Haute Pyr. 387, 1867. *Beccabunga anagallis* Fourr. in Ann. Soc. Linn. Lyon. (N.S.) 17 : 128, 1869.

According to Pennell this species should be written as *V. anagallis-aquatica* Linn.

Perennial succulent herb, erect or decumbent. *Stems* usually glabrous, rarely pubescent, hollow, 15-50 cm. long. *Leaves* sessile, rarely shortly petioled, lanceolate, oblong-ovate or ovate-lanceolate, acute or obtuse, entire or serrate, base usually auriculate rarely cordate, glabrous, 2-11 cm. long. 0.3-3 cm. wide. *Inflorescence* axillary, many-flowered raceme. *Flowers* pedicellate, bracteate (bracts conspicuous), white or pink, small, 4-6 mm. in diam. *Calyx* : sepals 4, polysepalous, ovate, sub-acute, 2-4 mm. long. *Corolla* : petals 4 , gamopetalous, rotate, lateral outermost, broadly elliptic 0.25-0.3 cm. long, upper lobe broadly ovate, 0.25 cm. long, white or pink. *Stamens* exserted ; anthers obtuse. *Ovary* round. *Fruit* a capsule, compressed, orbicular or orbicular-oblong notched, glabrous, 0.2-0.25 cm. long. *Seeds* ovoid or oblong, biconvex, rugulose.

Kung-met, 3rd Aug. 1884, *Dungboo* 300 ; Dong-dong, 10th July 1906, *J. C. White* ; Kamikha, March 1893, *King's collector* ; Goalpara

(90 m.), 5th March 1886, *C. B. Clarke* 43175A ; Maldah, 29th April 1874, *C. B. Clarke* 26264 ; Lakhimpur (Libru river banks), 29th March 1915, *H. G. Carter* 41139.

(*a*) **Veronica anagallis** Linn. var. **montioides** Boiss. Fl. Orient. 4 : 437, 1879 ; Fl. Brit. Ind. 4 : 293, 1885. *V. pusilla* Benth. in DC. Prodr. 10 : 468, 1846.

Dwarf, slender herb. *Stems* often simple. *Leaves* sessile, opposite, acute, sub-acute or obtuse, entire or serrate, 0.2-1 cm. long, 1-5 mm. wide. *Inflorescence* in racemes, few-flowered.

Sangopo Valley (Brahmapootra), July 1904, *H. J. Walton.*

7. **Veronica deltigera** Wall. [Cat. 402, 1828] ex Benth. Scroph. Ind. 45, 1835 ; Benth. in DC. Prodr. 10 : 475, 1846 ; Fl. Brit. Ind. 4 : 292, 1885. *V. lanosa* Benth. Scroph. Ind. 45, 1835. *V. rupestris* Aitch. & Remsel in Journ. Linn. Soc. 19 : 180, t. 25, 1882.

Perennial herb. *Stems* many from the root, rigid, slender, subsimple, ascending, pubescent, with prominent nodes. *Leaves* sessile, opposite, ovate, ovate-oblong or oblong-lanceolate, serrate, base-rounded or acute, glabrous, 1-4 cm. long, 3-15 mm. wide. *Inflorescence* terminal or axillary in short peduncled, pubescent racemes. *Flowers* pedicellate, blue, bracteate ; bracts often leaf-like, upper oblong, 1-2 cm. in diam. *Calyx* : sepals 4, gamosepalous, linear-oblong, sub-acute, 0.2-0.4 cm. long. *Corolla* 4- or 5-lobed, lobes broad, ± 6 mm. long. *Stamens* : filaments short ; anthers basifixed. *Ovary* : style filiform, 3-6 mm. long ; stigma sub-capitate. *Fruit* a capsule, oblong-ovoid, obtuse, ± 4 mm. long, equalling or shorter than the calyx. *Seeds* minute, irregularly suborbicular, plano-convex, much flattened.

Gopian-Than, Aug. 1821, in Herb. Cal.

8. **Veronica himalensis** D. Don, Prodr. Fl. Nep. 92, 1825 ; Benth. in DC. Prodr. 10 : 467, 1846 ; Fl. Brit. Ind. 4 : 292, 1885. *V. grandiflora* Wall. Cat. 403, 1828.

Herbs. *Stem* stout, erect, glabrous, 30-60 cm. long. *Leaves* sessile, in distant pairs, lower opposite, upper rarely alternate, ovate-lanceolate, all coarsely irregularly serrate, acute, 4-9 cm. long, 1-3 cm. wide, base rounded or auriculate ; nerves beneath pubescent. *Inflorescence* in erect racemes, axillary, towards the apex of the branches ; peduncles long. *Flowers* pedicellate (pedicels about equalling the calyx), bracteate (bracts 5-8 mm. long, linear-oblong), blue. *Calyx* : sepals 4-5, united at the base, oblong, acute, hairy, 6 mm. long. *Corolla* : petals 4, oblong, large, 8 mm. long. *Stamens* alternate with petals ; anthers sagittate. *Ovary* : style filiform, 6-9 mm. long ; stigma subcapitate. *Fruit* a capsule, ovoid, acute, ± 7 mm. long. *Seeds* minute, irregularly suborbicular, plano-convex, flattened.

Chakung chu (3400-3700 m.), 30th July 1910, *W. W. Smith* 3969 ; Ninghil (4000 m.), 7th Aug. 1910, *W. W. Smith* 4123 ; Zemu valley (3700 m.), 11th July 1909, *Smith & Cave* 1214 ; Gararang pasture, Sept. 1901, *Prain's collector* 189 ; Bogtop, Oct. 1908, *Ribu* ; Damkerka (3700 m.), Aug. 1888, *King's collector* ; Dothes, July 1879, *Dungboo.*

9. **Veronica hederaefolia** Linn. Sp. Pl. 13, 1753 ; Benth. in DC. Prodr. 10 : 490, 1846 ; Boiss. Fl. Orient. 4 : 468, 1879 ; Fl. Brit. Ind. 4 : 294, 1885. *V. cymbalarifolia* J. F. Gmel. Enum. Tubing. 6, 1772. *V. lappago* Schrank, Baier Fl. I : 218, 1789 ; *V. umbrosa* Reichb. ex Schult. Mant 1: Add. 11. 229 in syn. 1822 ; *Cochlidiospermum hederaefolium* Opiz. Seznam 31, 1852. *C. lappago* Opiz. in Lotoz. 4 : 158, 1854. *Pocilla hederaefolia* Fourr. in Ann. Soc. Linn. Lyon, N.S. 17 : 129, 1869.

Herb. *Stems* prostrate, hairy or glabrous ; branches numerous. *Leaves* petiolate (petioles 0.3-1 cm. long), orbicular-ovate, 5-7-lobed (lobes rounded), alternate or opposite pubescent or glabrous, 0.5-2 cm. long, 0.8-2.5 cm. wide. *Inflorescence* solitary. *Flowers* pedicellate (pedicels 1-2.5 cm. long), axillary, bracteate. *Calyx* : sepals 4 or 5, membranous, cordate, acuminate, ciliate, exceeding the corolla, persistent. *Corolla* : petals 4 or 5, pale blue, ± 6 mm. diam. *Stamens* : anthers oblong. *Ovary* : style filiform ; stigma subcapitate. *Fruit* a capsule, globose ; cells 1- or 2-seeded. *Seeds* large, rugose, subglobose, with a deep pit on the inner face, black.

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Report on the status of the Brow-antlered Deer of Manipur (India):

October-November 1959 and March 1960

BY

E. P. GEE, M.A., C.M.Z.S.

(*With 3 plates and 3 maps*)

(*Communicated by the Survival Service Commission of the International Union for the Conservation of Nature and Natural Resources*)

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I. INTRODUCTION

This report deals with *Cervus eldi eldi* McClelland, 1842, the Manipur (India) subspecies of a very beautiful deer which is only found in the south-western portion of the Logtak Lake in Manipur—a State of the Indian Union. In recent years it has become very rare, and for its preservation it became evident that more information about its numbers, habits, habitat, and so on was needed. This survey, sponsored by the International Union for the Conservation of Nature and approved of by the Indian Board for Wild Life, attempts to supply the required information, and makes recommendations for ensuring the continued survival of this subspecies.

The three sub-species of this deer may be briefly enumerated as follows:

(i) The Manipur subspecies, *Cervus eldi eldi* McClelland, 1842: Now found only in one small 10-square-mile (26 sq. km.) portion of the valley area of Manipur State in India. Locally known as *sangai* or *shangai*, and not as *sangnai* or *sangrai* as stated by Lydekker and certain subsequent writers. The stags commence shedding their antlers late in June, and new antlers are in velvet till November when they become full size. In December they become clear of velvet and hard, and remain so till early June. The rutting season is at its height in February and March, and the fawns are born in October and November. Fuller descriptions of its habitat and habits are given later in this report.

(ii) The Burma subspecies, *Cervus eldi thamin* (Thomas), 1918: Found in Upper and Lower Burma, and also possibly in parts of Thailand. Locally known as *thamin* or *thameng*. In 1955 U. Tun Yin made a compilation of reports received from Forest Officers, and concluded that there were then 3000—3500 *thamin* in the Union of Burma; and L. M. Talbot, who visited Burma in 1955, gave an estimate of 2500—3000. But subsequent reports from Burma indicate that the number may now be considerably less. For, although the *thamin* was declared by the Government of the Union of Burma in 1956 to be a 'completely protected species', it is feared that a great deal of illicit shooting is still going on.

(iii) The Thailand subspecies, *Cervus eldi siamensis* Lydekker, 1915: Found in Thailand and Viet Nam (and possibly in Cambodia, Laos, Viet Minh, and Hainan). Known in Thailand as *la-ong la-mang*, or *la-mang* for short (a big stag with good antlers is usually called *la-ong*, and a young stag or hind *la-mang*). In Cambodia it is known as *la-miang*. Formerly it abounded on the open plains and in the deciduous forests of Thailand, but now it is reliably reported by Dr. Boonsong Lekagul *in litteris* (May 1960) that it is on the verge of being lost. Only a few herds of four or five head are to be seen at Nang Rong in the north-east and at Chieng Karn in the north, and it is doubtful if these can be saved from extinction unless the Thai Government can take quick and effective steps to protect them.

The stags of the Browantlered Deer, or Eld's Deer, are described as standing about four feet (1.22 m.) high at the shoulder, and weighing from 210 lb. (95 kg.) to 245 lb. (111 kg.). The hinds are smaller. The maximum length of the antlers is 42 in. (107 cm.). The coat of the stags is rather coarse, and they develop a mane. There is a seasonal change in their coloration, from brown in the winter to chestnut in the summer. The young are spotted; and traces of spots can be seen in adults, even after several years.

This deer is readily distinguished from all other species of deer by the peculiar form of the antlers. These are set in the head at right angles to the pedicle, and the curve of the brow tines is continuous with that of the beams. The antlers of opposite sides are unsymmetrical when compared with one another. The beams are unbranched for some distance, much curved, and finally forked. In older stags the forward bend makes a distinct angle in the beam, while in young stags the curve is more continuous, like a prostrate letter C. The antlers of the Thailand subspecies are generally, if not always, palmated terminally.

The pasterns of the Manipur subspecies are hairless, hard, and horny, specially adapted for moving about on swampy ground and for preventing it from sinking through the surface mat of reeds and grasses. The pasterns of the Burma and Thailand subspecies, which live in dry undulating country, are hairy.

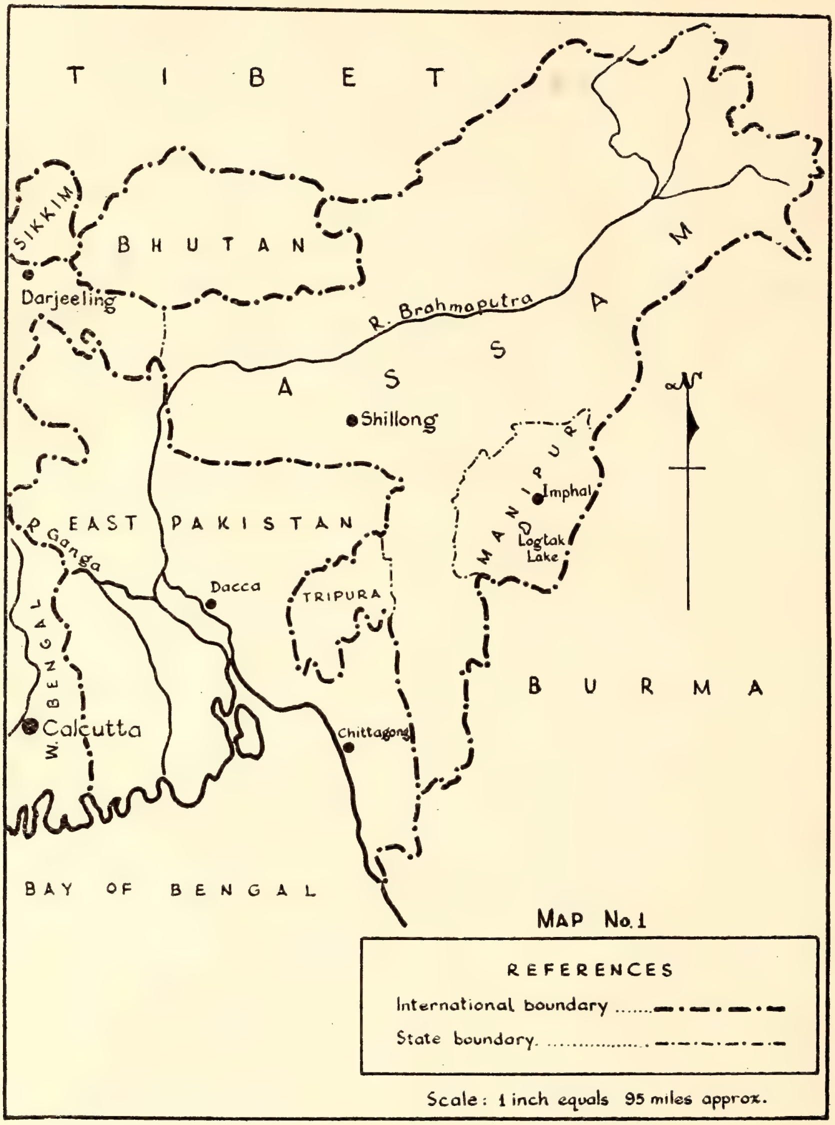
II. General Review and Summary of Report

Although this Manipur subspecies of Browantlered Deer has been officially protected, since 1934 by the Manipur State Durbar and since 1954 by the Government of Manipur, it is probably true to say that it owes its existence more to the fact that (1) Manipuris are vegetarian in diet, and (2) the animal lives not in an ordinary swamp, but in a *floating* swamp which is almost impenetrable to human beings at most times of the year.

Hitherto, most of the information about the habits and habitat of this deer has been given, incidentally for the most part, by sportsmen who have tried to track and shoot stags. No attempt appears ever to have been made by a biologist or a naturalist to study the deer and its unusual habitat of floating humus, or *phumdi*, on which grow tall reeds and grasses, often up to 15 feet (4.6 m.) in height.

The Manipur Administration has very commendably protected the deer and created a 10¾ square mile (27.8 sq. km.) sanctuary called Keibul Lamjao for its preservation. This sanctuary requires the fullest protective measures, and recommendations to this end are given in section VIII. After two visits to this sanctuary, in October-November 1959 and in March 1960, I estimate that approximately 100 of this Browantlered Deer now exist in Manipur.

It is considered that here is a good case for the preservation of rare and endangered animals by humanely capturing some of them and keeping them in a good zoological park or garden. It is extremely difficult, in fact almost impossible, to see or observe this deer in its natural habitat; and as it may have formerly existed in


TIBET
SIKKIM
BHUTAN
Darjeeling
R. Brahmaputra
ASSAM
Shillong
MANIPUR
Imphal
Logtak Lake
EAST PAKISTAN
R. Ganga
W. BENGAL
Calcutta
Dacca
TRIPURA
Chittagong
BURMA
BAY OF BENGAL
REFERENCES
International boundary ....
State boundary ....
Scale : 1 inch equals 95 miles approx.

MAP No. 1

undulating grassy areas near the foothills (as the Burma and Thailand subspecies now do), and as it is known to thrive and breed in captivity, it seems only reasonable that a few of them should be captured by the government department in charge of them, and kept under zoological park conditions.

As such they would not only be preserved and their numbers increased, but also they would be available for scientific observation, and be an attraction to the people of Manipur as well as to visitors from outside and tourists from abroad.

III. History of the Browantlered Deer Area in Manipur

Before India became independent, Manipur was a princely state under its Maharaja, with a British Political Agent or Resident in charge of external and foreign affairs. The Maharaja had full charge of internal affairs, and was responsible for law and order. His 500 State troops were called in by him to assist the State police if a serious disturbance arose. If a disturbance could not be quelled by these, the last resort was the battalion of Assam Rifles under the control of the British Political Agent. A rebellion occurred in 1891. The nearest British garrison station was Kohima in the Naga Hills, and the road connecting Assam, Kohima, and Imphal in Manipur was opened in 1896.

During World War II nearly the whole of Manipur State, except the area round Imphal town and airfield, was occupied by Japanese troops from 1943-45. Later on the invading forces were driven back into Burma.

On India's achievement of independence in 1947 Manipur became a Class C State of the Indian Union with a legislative assembly. This was dissolved in 1948 and replaced by Chief Commissioner's rule under the Centre (New Delhi). Since the Reorganisation of States in 1957, Manipur has been a Territory of the Indian Union (like Tripura, Himachal Pradesh, and Delhi) with the Chief Commissioner in charge of the Manipur Administration, who is responsible to New Delhi. There is a Manipur Advisory Committee consisting of the Chief Commissioner, three members from Manipur of the Lok Sabha, and the chairman of the Territorial Council. The latter Council is elected from the people of Manipur and has control of education (except colleges) and of roads, except the national highway from Mao to Moreh, which is under the Manipur Administration. Since May 1960 there has been some political agitation in the State for the reconstitution of a legislative assembly in place of control from the Centre.

As for the *sangai*, prior to 1891 they were recorded (Alban Wilson, 1924) as having been 'preserved by order of the royal family, and any man who was proved to have killed one had his hand chopped off, but after we took over the affairs of the State the deer were allowed to take their chance, and the Mahommedans who lived in the vicinity were not long in waking up to the fact. They used to mount their buffalo, armed with spears, ride quietly up to the deer, surround them in the heavy grass, and then stick them . . . Luckily a sporting Political Agent finally issued orders to preserve this rare beast from indiscriminate slaughter . . .'

Protection given to the *sangai* is also referred to by H. S. Wood (1934): 'The various political officers of Manipur recognising the paucity, and probable extinction, of this animal, have framed very strict hunting rules, and the number of heads is limited . . .'

In 1934 by order of the Manipur State Durbar it was resolved that no further permits be issued for shooting these deer until further orders, as this animal was in danger of extinction.

In December 1951 the Government of Manipur informed the writer of this Report that 'enquiries have been made by the Forest Department and it has been found that this deer has become totally extinct and no alive specimen is now available . . . In view of what is stated above there is no need to establish a Wild Life Sanctuary at present.' Accordingly the writer informed the International Union for the Conservation of Nature and Natural Resources that this subspecies had been reported as extinct. But he as well as Lt.-Col. R. W. Burton and Shri P. D. Stracey (then Senior Conservator of Forests, Assam) continued their efforts to obtain further information and to protect the deer in the event of their being found.

Subsequently it was found that the deer did actually exist, and in October 1953 the whole of the Logtak Lake area was closed to shooting and declared a sanctuary by the Government of Manipur in order to protect it. Later on it was pointed out that it was unnecessary to close the whole of the lake to shooting as this deprived many *bona fide* sportsmen of their legitimate goose- and duck-shooting, and consequently in July 1954 the Logtak was opened to shooting—except the southern portion where the deer existed, which was made into a sanctuary of approximately 20 square miles (52 sq. km.) in extent. The area became reduced and in 1959 this Keibul Lamjao Sanctuary was surveyed and officially reported as being about 10¾ square miles (27.8 sq. km.).

IV. GEOGRAPHY AND ECOLOGY

Manipur, now a territory of the Indian Union, lies between Burma and the north-eastern portion of India, and consists of a valley area, which is surrounded by a hills area, between 23° 47′ and 25° 41′ north latitude and 93° 6′ and 94° 48′ east longitude. The broad open valley is about 750 square miles (1942 sq. km.) in extent, and about 2500 feet (762 m.) above sea-level; and a peculiar feature of this plain is the existence of many small hillocks dotted over the whole area. The hills area is about 7500 square miles (19425 sq. km.) in extent, rises up to some 10,000 feet (3048 m.), and consists of ranges of hills mostly running north and south.

The six large streams, as well as numerous small ones, which drain from the hills into the central plain, all combine to flow out again southwards through a narrow gorge into the Chindwin River in Burma. Consequently the southern portion of the valley contains a number of lakes and marshes, with variations in their conformation owing to changing flood levels and growths of reeds, grasses, and floating water weeds.

The Logtak is the largest of the lakes, and is over 25 square miles (64.75 sq. km.) in extent. Smaller lakes or *jheels* are dotted about, some of which dry up in the dry season either completely or with just a few pools of water remaining. A large part of the valley area is under a few inches of water during the rainy season, April to mid-October, and rice is extensively cultivated. The valley is not 'one huge swamp' as reported by Lydekker.

From figures given by D. B. Deb (1960) for Imphal, which is only 20 or so miles (*c.* 32 km.) from Keibul Lamjao Sanctuary, the average annual rainfall is 122 cm., and the mean daily humidity is highest in August with 81% and lowest in March with 49%. The maximum temperature is 34.44° and the minimum 1.66° Centigrade. Frost is common in the valley during December and January.

Keibul Lamjao Sanctuary consists of roughly 10 square miles (26 sq. km.) of 'swamp'. I have purposely enclosed the word swamp in inverted commas, because it must be explained at the outset that this is no ordinary swamp. It is a floating swamp. Tall reeds and grasses and other plants grow on a mat of dead or decaying vegetation; and this mat actually floats on the lake with approximately 1/5 of it above the surface of the water and 4/5 of it below.

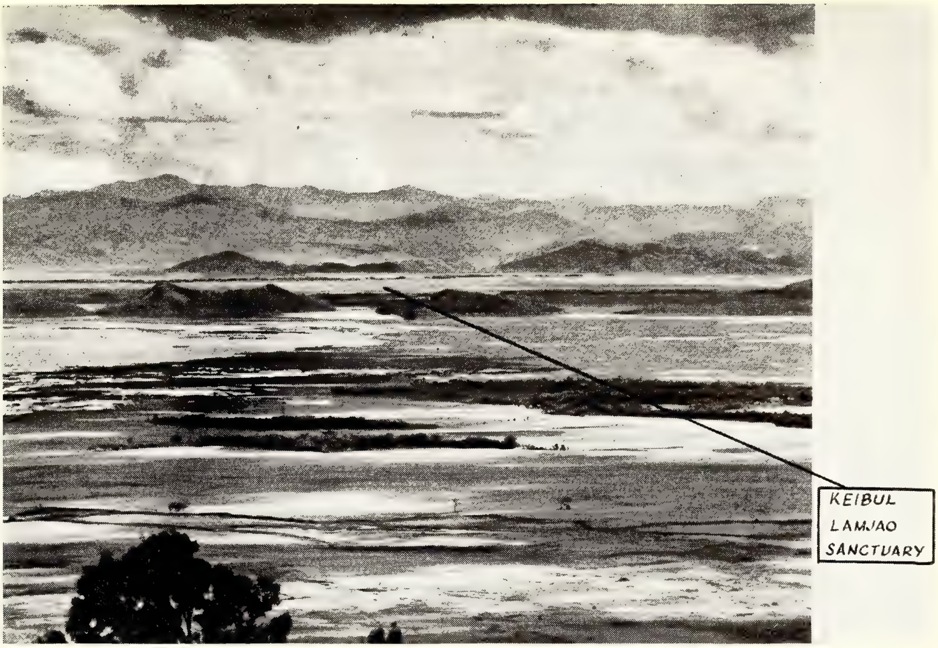
The extraordinary thing is that no sportsmen, naturalists, or other writers have recorded this fact before. Lt. Eld (1841) described the area inhabited by the deer as follows: 'Its favourite haunts are the low grass and swamps round the edge of the Logtak (lake) . . .' A. H. D. Barron (1911) mentions swamp. Lt.-Col. Alban Wilson (1924) refers to the area as a 'sea of grass'. Lt.-Col. C. H. Stockley (1928) describes it as 'grassy swamps', and goes on to say that 'poles are carried by which the *shikari* may ascend to spy, having stuck the end into the soft surface'. Even J. C. Higgins (1934), a naturalist of repute, wrote of this deer as being found in 'the swamps and bogs in the south of the Manipur Valley, and nowhere else in the State . . .'

Lt.-Col. H. S. Wood (1934) was a little nearer the mark when he referred to the floating islands of the Logtak Lake. He described this deer's habitat on the southern shore of the Logtak Lake as 'a huge morass consisting of dense reeds, grass, and water, and covered with algae and weeds . . . huge bog . . . here also were numerous floating islands, and during heavy floods I have found the deer leave them for comparatively dry ground at the bases of the low hills skirting the morass on the west.'

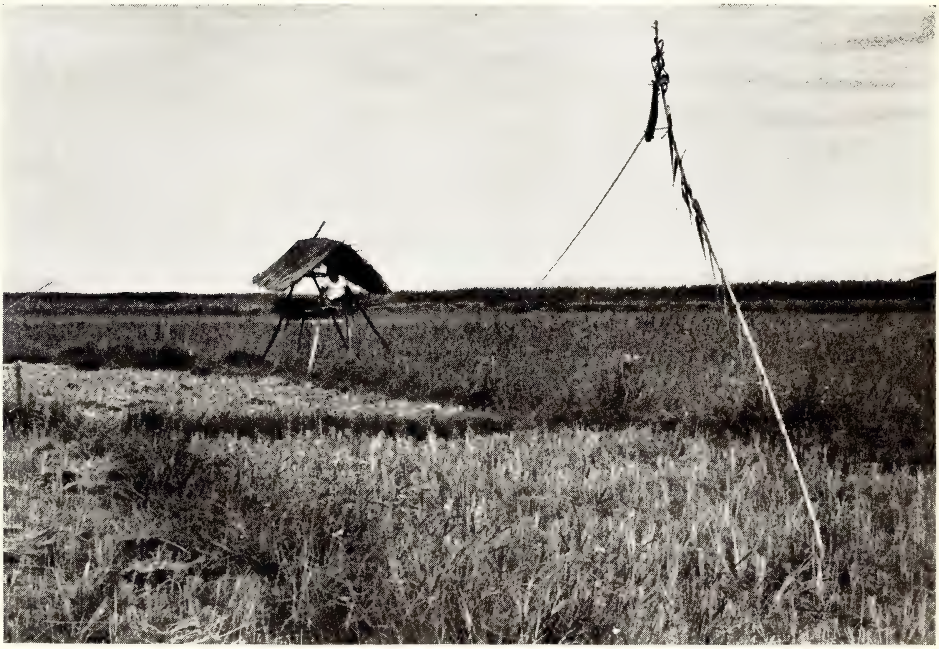
No one appears to have realized that the habitat of this deer near the shore of the Logtak Lake consists of what the Manipuris call *phumdi*. *Phum* or *phumdi* is a mat of organic matter in which reeds and grasses grow, often up to 15 feet (4.5 m.) or more. It is subdivided into *phumdi arupa* (sinking) and *phumdi ataoba* (floating). There is a seven-foot-long implement called *phumlen thangol* for cutting *phumdi* when a canal or passage is made. As mentioned before, *phumdi* floats on the water, with about 1/5 of it above the surface and 4/5 of it below. *Phumdi* varies in thickness from 6 inches (15 cm.) to about 5 feet (1.5 m.), and where it is thick a man can walk though he will sink to his knees or further in the soft mat. Should he accidentally tread on the mat where it is thin, he will go right through it into the water beneath.

Floating islands, floating bogs, or floating swamps are found, I understand, in Burma, the U.S.A. (at Minnesota), and in Britain (some peat bogs). Only the most enthusiastic of sportsmen went after this deer. To quote again from Lt.-Col. H. S. Wood: 'When stationed in Manipur from 1891 to 1898, I had exceptional opportunities of observing and hunting this deer . . . no other animal could exist in such swamps . . . The action of this deer is very peculiar. Instead of bounding with fore- and hind-feet coming on to the ground at the same time, it seems to be proceeding on its hind legs, the body being held almost vertical. This action prevents it from sinking in the quagmire . . . My method of hunting the Manipur stag was by stalking in this stuff, and if anyone wishes to attempt it, let him prepare himself for frequent duckings. It is very strenuous work and a torment owing to mosquitoes . . . My major, whom I took out one day, gave it up in the first few hundred yards after many cursings.'

A sportsman friend of mine who went after these deer in 1950 wrote to me as follows: 'From the point of view of making this a sanctuary in which visitors could see these animals I think it would

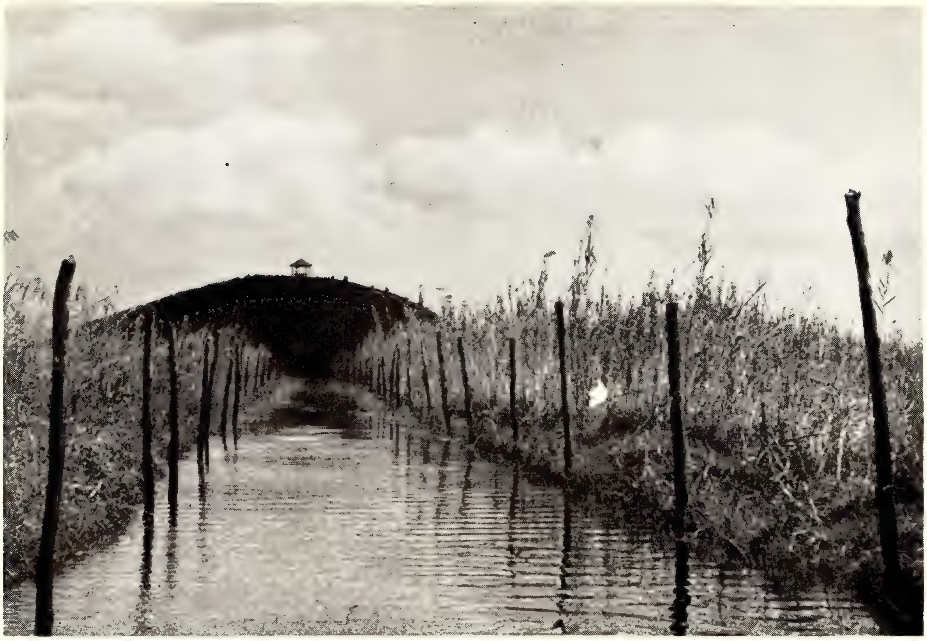

KEIBUL
LAMJAO
SANCTUARY

The Sanctuary as seen from the hill west of Bishenpur. Part of the Logtak Lake can be seen at the left of the picture

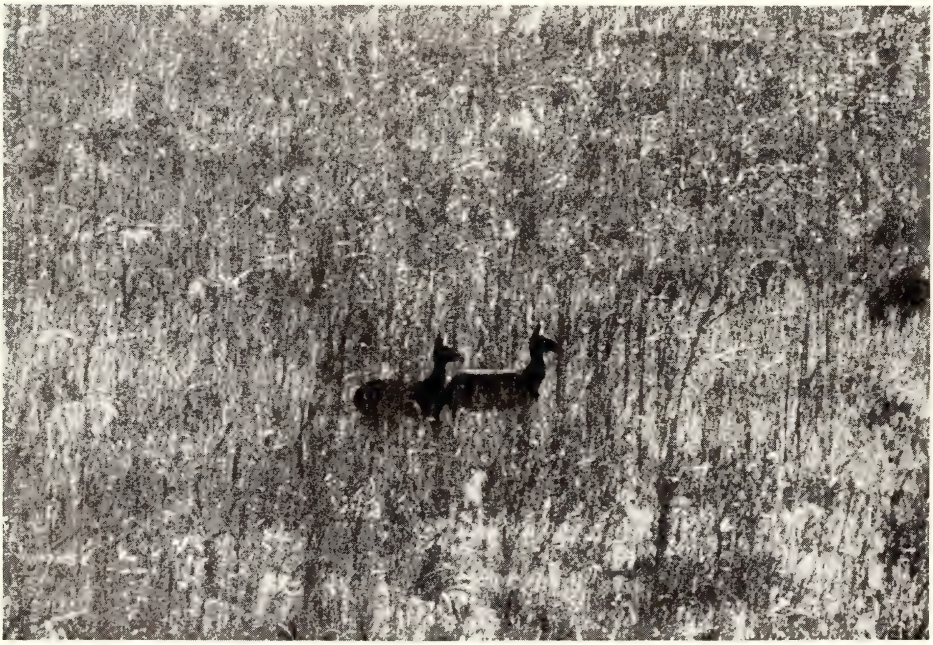


Shed and contrivance for driving away wild pigs from rice fields

Photos : E. P. Gee



Canal with observation hillock and tower



Hind and fawn Brow-antlered Deer photographed in Keibul Lamjao Sanctuary, March 1960

Photos : E. P. Gee

be a failure . . . it is terrible going, very deep swamps and one has to jump from hillock to hillock across deep ruts. If one should be unfortunate to fall in such a rut one goes in up to one's waist! . . . Again I can only repeat the difficulties of stalking these beasts. The going is *shocking* and they lie up in the most inaccessible places, often surrounded by bogs through which a man cannot pass.'

In places where the *phumdi* (of the *ataoba* or floating type) is non-existent, a reed locally known as *ishing kombong* (*Saccharum latifolium*) grows on the bed of the lake in the sinking *phumdi* (*phumdi arupa*), and approximately 5% of the area of the sanctuary consists of this. It is eaten by the deer and by domestic buffalo. The reeds and grasses which grow on the floating *phumdi* are as follows:

tou	*Phragmites karka*	45%	of the sanctuary.
singut	(not yet identified)	25%	
khoimum	*Saccharum munja*	15%	
ishing kombong	*Saccharum latifolium*	5%	
pulai	*Alpinia allughas*	5%	
singnang	*Saccharum procerum*	2%	
Miscellaneous		3%	

There is no water hyacinth in the sanctuary area, except a very small amount near the edge. Presumably it cannot compete with the thick reeds and grasses which are listed above. The average thickness of the *phumdi* in the sanctuary area in October is about 3 to 4 feet (90 to 120 cm.), with about 4 to 5 feet (120 to 150 cm.) of water underneath. In time of floods this 4 to 5 feet (120 to 150 cm.) average would become 5 to 6 feet (150 to 180 cm.); while in March at the driest time of the year it would be 2 to 3 feet (60 to 90 cm.) or even less, and in very shallow places the *phumdi* would then be resting on the ground.

The small hilly area included in the sanctuary to the south-west is mostly denuded of vegetation by overgrazing by village cattle. To this high ground the deer sometimes move in times of very heavy rain which takes time to seep through the *phumdi*. As soon as this surface flooding of the *phumdi* has disappeared, due to the *phumdi* eventually floating again on the surface of the lake, the deer return.

Wild Pig and a few Hog Deer share this floating sanctuary with the Browantlered Deer. I was informed that Wild Dog do not and cannot exist in this area, but that occasionally a Leopard has been observed in it. Of bird life, only the smaller reed-dwelling species were observed. Larger wading and swimming birds appeared to be non-existent, as there are no open patches of water in the sanctuary.

There are villages all along the western and southern boundaries of the sanctuary, with large numbers of buffalo and cattle and with extensive rice cultivation. Cattle cannot enter the *phumdi*, but domestic buffaloes graze over about two and a half square miles (6.5 sq. km.) of the sanctuary. A strip of waste land along the western side of the sanctuary has been encroached on and cultivated, and a narrow wedge of approximately 60 acres (24 hectares) right inside the sanctuary has been cultivated by these villagers. Fishing from approximately 1000 narrow dug-out boats is done throughout the sanctuary area, along the narrow tracks where the *phumdi* is very thin or non-existent. From the end of the forest road to the edge of the sanctuary, to the hillock named Chinjao Hill on which the observation hut has been built, a canal has been cut through the 5 feet (152 cm.) thick *phumdi*. This canal is 15 feet (4.6 m.) wide, and 2800 feet (850 m.) long, and cost over Rs. 6000 (£450) to cut.

V. ADMINISTRATIVE AND POLITICAL

In the Manipur Administration, which is under the Chief Commissioner, the Secretary (Miscellaneous) has charge of the Forest Department. The Head of this Forest Department is the Chief Forest Officer, and the Keibul Lamjao Sanctuary has been placed under the Range Officer, Moirang, since January 1st 1959. The Forest Staff in charge of the sanctuary at the time of my two visits consisted of one Forester, one Forest Guard, and one Game Chaprassi.

In the last census the population of Manipur was given as (approximately) 600,000, of which 200,000 were in the hills area, and 400,000 in the valley area. Of these 400,000 in the plain, 200,000 were in Imphal town itself and 200,000 out in the villages. Since then the above populations have probably increased by 50% owing to natural increase and the influx into Manipur of displaced persons, Nepalis, and others. It will be seen, therefore, that the valley area is very thickly populated, and all the available land is under rice cultivation.

The Keibul Lamjao Sanctuary itself is flanked on the north-west, west, and southern sides by Thanga, Keibul, Kumbi, and other villages, the inhabitants of which are fortunately Manipuris who are vegetarian in diet and therefore do not hunt or kill the deer. To the north-east of the sanctuary however, there are the four Mussulman villages of Uchiwa, Mayang Imphal, Turen Ahaubi, and Samusang, whose inhabitants would (if given the chance) hunt and kill the deer. I was informed that no guns were possessed by any of the villagers.

Three offence cases, I was told, of 'encroachment in the sanctuary and of shooting animals' were detected and dealt with in 1955-56, and none in the subsequent years.

The fishing rights in the sanctuary area are auctioned annually; and were sold during the current year for Rs. 3000 (£225). Reed cutting of *tou, singut,* and *singnang,* mainly on the eastern side of the sanctuary, was sold in two lots for Rs. 800 (£60) and Rs. 700 (£52/10). Fishing in small dug-outs in the sanctuary probably does not unduly disturb the deer, and may be regarded as a long-established 'right' of the local inhabitants with which it would be inadvisable to interfere.

Similarly reed-cutting is a local economic necessity and has been done since time immemorial, as the reeds are used for the building of walls of houses and as firewood; and the cutting and burning of reeds results in fresh growth, which is palatable to the deer. Incidentally, I found during my March visit that burning off of the reeds and grasses was only partially successful—unless they had previously been cut and left *in situ.* Cutting followed by removal of reeds and grasses would probably not facilitate burning, but would none the less produce new shoots.

Regarding the narrow strip of waste land along the western edge of the sanctuary, amounting to about one square mile (2.6 sq. km.) in extent, I was told that the villagers were claiming it and cultivating it, and that there had been some dispute between the Forest Department who wished to include it in the sanctuary and the Revenue Department who considered that it should be opened up for cultivation. I understand that it will now be difficult, if not impossible, to prevent cultivation here. There is a thin wedge of rice cultivation right in the centre of the sanctuary, amounting to some 50-60 acres, which should be stopped if possible.

I found that the local people, even educated persons, knew very little about deer and other wild life. The Mahommedan *shikaris,* who have for generations accompanied the sportsmen who have come here for goose-, duck- (and deer-) shooting, are the only people who have a working knowledge of 'game' animals and birds.

When I asked what were the reactions of the local villagers to the creation of the sanctuary, I was told that those people who were cultivating the strip of waste land along the western edge and the central thin wedge inside the sanctuary objected. Otherwise there were no adverse reactions except from those whose rice fields were raided by wild pigs from the sanctuary. The owners of the domestic buffaloes which grazed within the boundaries of the sanctuary would also probably protest if deprived of this facility.

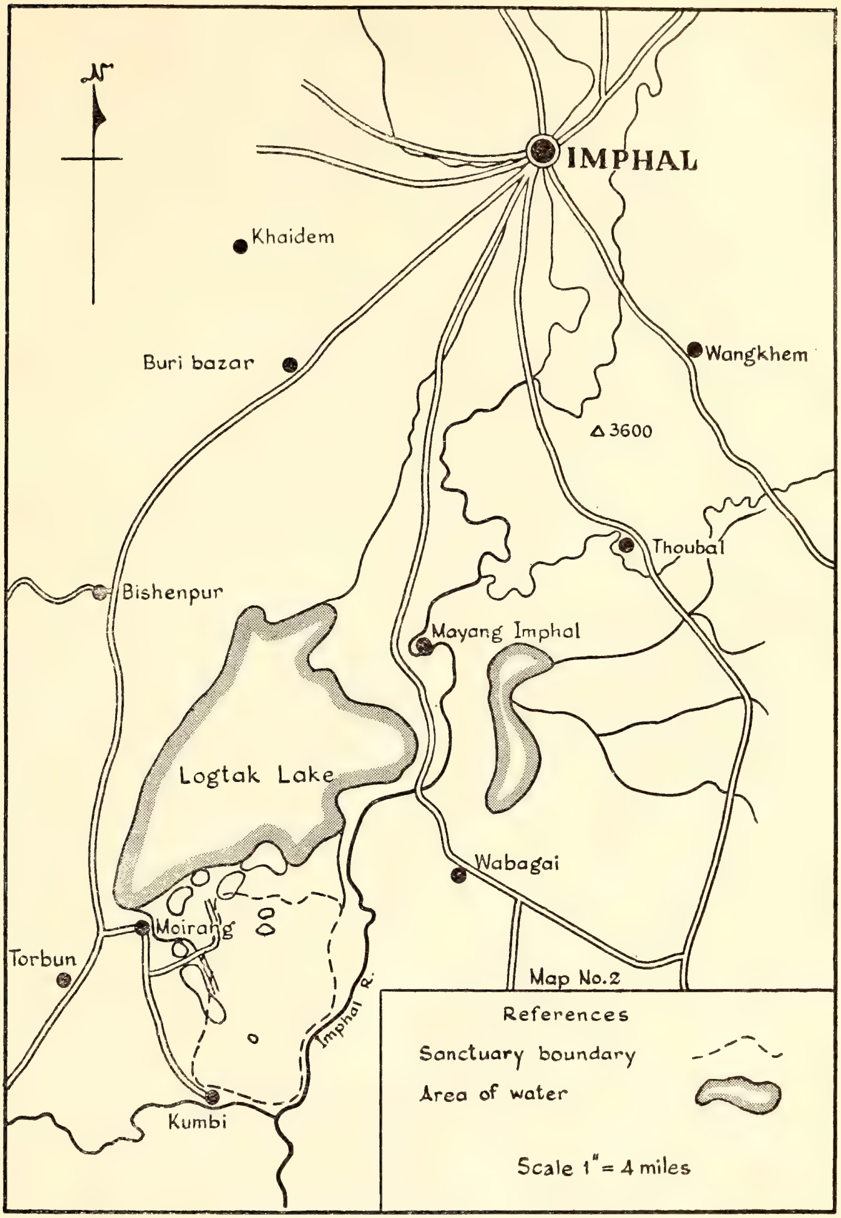
VI. General Account of the Survey

First of all, a permit to visit Manipur was obtained—a formality obligatory on all who are not Indian nationals, mainly because of the Naga Hills being a 'disturbed' area. The fullest co-operation of the Forest Department had previously been offered to me by the Chief Forest Officer. On October 21st, at the end of the monsoon, I motored in my Land Rover (with trailer) to Imphal, via Kaziranga, Garyampani, Dimapur, Kohima, and Mao. From Dimapur to Kohima it was obligatory to travel in the daily armed military convoy, as the road to Manipur runs through the Naga Hills. One day was spent in Imphal in order to contact the Chief Forest Officer, and the Deputy Commissioner (who is Chairman of the Wild Life Board there). The nights of the 26th and 28th to 31st were spent at Moirang, which is 26 miles (41.8 km.) from Imphal and 4 miles (6 km.) from Keibul Lamjao Sanctuary—the object of my tour.

It was fine, sunny weather. The rice in the fields was still green, and the road to the sanctuary muddy after the monsoon rains. We saw many small sheds (*lousang*) in the fields for driving away wild pigs. At the end of the forest road to the sanctuary, a boat met us and took us along the canal through the *phumdi*. Numerous light brown mosquitoes and two leeches failed to discourage me. On arrival at the observation tower on the 150 feet (45.7 m.) high hillock known as Chingjao Hill, I found that a good view was obtainable of the sanctuary, which looked like a sea of reeds and grasses.

As it had taken us two hours to reach this spot, partly by Land Rover and partly on foot, and as it was only from this observation tower on the hillock that there was a chance of seeing anything, I decided to remain there all that day and for the night, in order to avail myself of evening and early morning opportunities of seeing deer. There were protests from the Forest Staff and villagers, about danger from wild pigs, about discomfort from mosquitoes, and above all about the existence of evil spirits at that place at night. These did not deter me, and I sent back for the necessary bedding and food.

Several wild pigs were seen during the day; and very early in the following morning one of the men accompanying me had a close view of a stag and a hind, and later another hind, near the canal. Afterwards, on being shown the antlers of a Hog Deer and of a Brow-antlered Deer, he unhesitatingly indicated that it was the latter that he had seen. In another direction I myself saw three light-coloured


IMPHAL
Khaidem
Buri bazar
Wangkhem
3600
Thoubal
Bishenpur
Mayang Imphal
Logtak Lake
Wabagai
Moirang
Torbun
Imphal R.
Kumbi
Map No.2
References
Sanctuary boundary
Area of water
Scale 1" = 4 miles

hinds in the distance which were almost certainly Browantlered Deer.

The following days were spent in collecting information from the Forest Staff and from the local villagers. I visited Kumbi village on the south side of the sanctuary, and also the hill above Bishenpur for a view of the whole Logtak Lake area.

On November 1st I returned to Imphal, and showed six films of Indian wild life in a big hall, to which the Chief Commissioner and many other officials came. Then a trip along the national highway southwards to Moreh on the Burma border to see the country there. From near Tengnoupal the views of the Imphal valley to the north and Burma to the south were magnificent. Then I motored through the Naga Hills along the same route I had come, and returned to Shillong on November 8th.

My main impression of the sanctuary was that it was a most impenetrable place. Even in a large boat while travelling along the wide canal, we were bitten by mosquitoes and leeches; how much more difficult and uncomfortable would it have been to see the sanctuary by inching one's way in a tiny two-man unstable dug-out boat through the thick sea of grasses and reeds growing up to some 15 feet (4.6 m.) in height, with only a very remote chance of obtaining even a fleeting glimpse of a deer? When I referred to this difficulty, the reply was that March, not October, was the best time to visit the sanctuary, when some of the grasses and reeds had been burnt off and the water level lower.

So I decided to visit the sanctuary again in mid-March, the driest time of the year in these parts. The Chief Forest Officer agreed to try and conduct some kind of census of the deer when I arrived, and we discussed ways and means of doing this.

This time I decided to motor along a new road in the Khasi Hills to Cachar, and from there to fly over the mountains into the Imphal plain and thus save time. After a day and a half at Imphal, I motored along the new road right up to the canal in the sanctuary, and the boat was poled along to the observation hill just as the sun was rising.

I was surprised to find that the level of the lake had only sunk about 2 feet (61 cm.) since last October, and that there was still a great deal of water everywhere—and the *phumdi* still floating on it. Some patches of reeds and grasses had been burnt off by the Forest Staff without previous cutting, and were only partially burnt. Some other patches had been cut and then burnt off, more thoroughly. New shoots were appearing everywhere, and the places where *ishing kombong* grew in the bed of the lake (and not on the *phumdi*) were bright green with new growth. But, seen as a whole from the observation hill, the sanctuary still appeared to be a sea of reeds and grasses, with only small areas of open 'ground'. There was still a very great deal of cover for wild life, and hopes of doing a census of the deer rapidly faded away.

Carefully searching the area with binoculars, I saw a stag and hind Browantlered Deer about ½ a mile (800 m.) away, in the grass. In another place two half-grown fawns were playing, almost dancing round in circles, while their mothers grazed near by—unmistakably Browantlered Deer.

Twenty Manipuri villagers had been arranged to drive selected areas for conducting a census. These I decided to send out so that they could form a line and drive a representative area of about a quarter of a square mile (650 sq. m.) towards the hillock. I remained on the hillock with binoculars to observe results, as from the ground nothing can be seen except the grass immediately in front. The men denuded themselves of all clothing up to the hips, and set off—many of them with sticks to probe the *phumdi* for softer places in order to avoid a ducking. Soon they were all splashing their way through the black ooze which came well above the knees.

Out of this area came 4 Browantlered Deer, hinds and fawns, and 10 pigs. Two hours had passed by, and the men were not at all in favour of doing any more such drives in such heavy going. On the basis of this very limited investigation, I arrived at the following conclusion: The total area of the sanctuary was 10.75 sq. miles (27.8 sq. km.). Deduct from this the area grazed by domestic buffalo 2.50 sq. miles (6.5 sq. km.), the area of waste land and rice land under cultivation 1.00 sq. mile (2.6 sq. km.) and the hill area .25 sq. miles (650 sq. m.), and then 7 sq. miles (19 sq. km.) remained. At the rate of 16 deer per sq. mile (2.6 sq. km.), the total would be 112 Browantlered Deer in the sanctuary, say 100. Similarly 280, or say 300, wild pig also exist here.

The Indian Swamp Deer, *Cervus duvauceli*, does not exist and has never existed in Manipur. Barking Deer, *Muntiacus muntjak*, are found in the hilly, forested places. As for Hog Deer, *Axis porcinus* none were actually seen on my two visits to Keibul Lamjao Sanctuary. But evidence of their existence in the sanctuary is as follows: They are reported by Alban Wilson (1924) and Higgins (1934); a buck was killed shortly before my second visit at the edge of the sanctuary, and the head and antlers seen by the Range Officer; a head with antlers which had been found in the sanctuary was shown to me at the Beat Office of the sanctuary; and a pair of shed antlers said to have been found in the sanctuary was shown to me in Keibul village. Possibly some 25 Hog Deer exist in the sanctuary.

The Forest Staff in charge of the sanctuary and under the Range Officer of Moirang at the time of my first visit were as follows: 1 Forester (3 months there), 1 Forest Guard (10 years there), 1 Game

Chaprassi (3 months there). At my second visit, the first two of the above personnel had been changed, and I found: 1 Forester (17 days there), 1 Forest Guard (1½ months there), 1 Game Chaprassi (7½ months there). None of them appeared to have much knowledge of the sanctuary or of wild life.

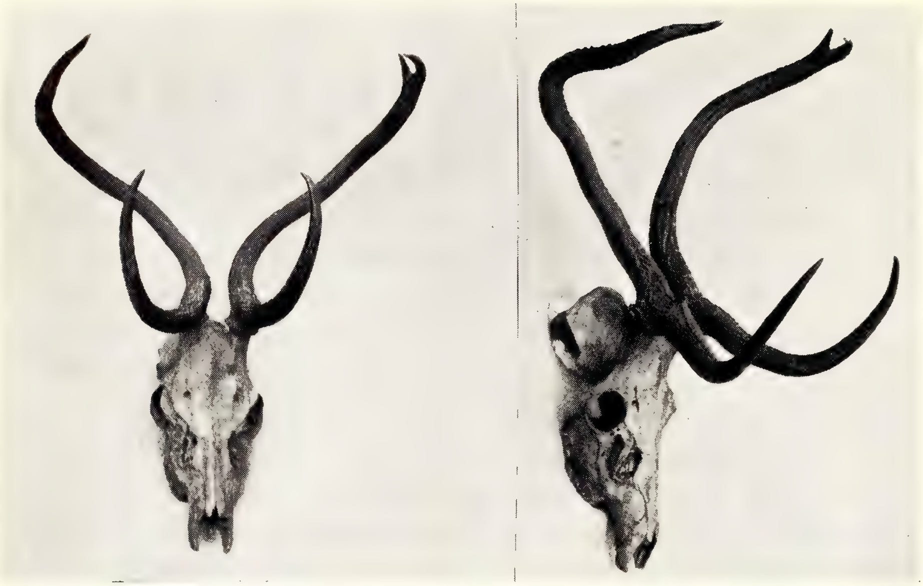
VII. STATUS, DISTRIBUTION, AND FUTURE OF THE BROWANTLERED DEER IN MANIPUR

FORMER AND PRESENT STATUS

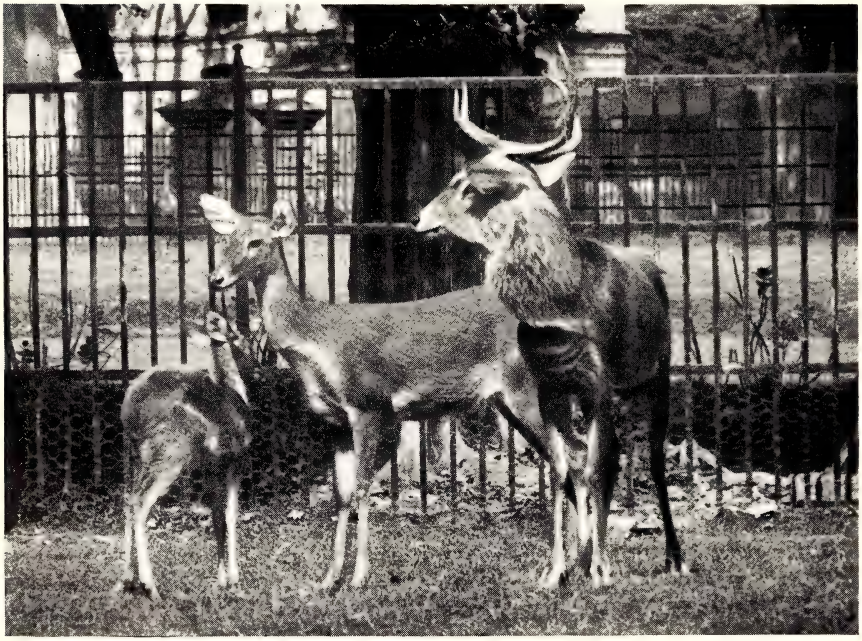
Information about the former range, distribution, and numbers of this deer in Manipur has to be searched for in the accounts given by sportsmen. In 1841 Lt. Eld wrote: 'It is gregarious in its habits, and after the annual grass burning, I have frequently seen herds of two or three hundred'. Lt.-Col. H. S. Wood, who was there from 1891-1898, recorded: 'Many years ago it was found in all the marshes of Manipur, but it was mercilessly hunted and trapped by the Mohammedan Manipuris, called Panguns, till we took over the State, when the Political Officer stopped all trapping . . . The Manipuri Deer is full of curiosity. The Manipuri name is 'Sangai' or 'the animal that looks at you', and exactly describes him . . . These deer are found in herds of six or seven, usually all does, the stag generally concealing himself very cleverly in the rushes and reeds . . . The Mohammedans kill them from dug-outs during floods, or spear them mounted on buffaloes. They also trap them by an ingenious method.' A. H. D. Barron in 1911 wrote of this deer that it '. . . keeps absolutely to the swamps, except perhaps during the rutting season, when he may be met in the long grass at the foot of the hills.'

J. C. Higgins (1934) stated: 'In the swamps it is fairly common, but, although nominally preserved by law, its numbers have decreased in late years, owing to the attentions of wild dogs and poachers. In times of high flood the wretched animals are driven out of their haunts to isolated pieces of high ground, where the neighbouring Nagas and Muhammadans take heavy toll, regardless of sex, age, close season or the rules directing the taking out of licences to hunt them.' I investigated the occurrence of wild dogs during my visits to this place, and was informed that these predators are now non-existent in the area concerned.

G. B. Eastmure has informed me in a letter that he was in this area in March 1947 and said: 'My experience of the Browantlered



Antlers of Manipur subspecies of Brow-antlered Deer



The Manipur subspecies photographed in the Alipore Zoo, Calcutta, in January 1960

Photos : E. P. Gee

Deer is slight, but I did spend four days out after a stag. In this time I saw several in twos and threes and two herds of about seven to eight beasts. The magnificent stag was seen through the glasses.' In 1951 these deer were reported as extinct, and then in 1952-53 were 're-discovered'.

I estimate that there are about 100 of these deer in existence today, confined to the area of the Keibul Lamjao Sanctuary, plus the stag, hind, and fawn in the Calcutta Zoo. I also consider that it is possible that this species may have formerly ranged over a larger area, including grassy undulating land at the foot of the hills, before being driven by increasing population and extending agriculture on to the *phumdi* of the Logtak Lake, which may after all be its present habitat by necessity and not of original choice.

FUTURE OF THE SUBSPECIES

In addition to being protected by law, this deer is protected by the impenetrability of its habitat and by the fact that most of the surrounding villagers are vegetarian Manipuris. In actual fact, its survival during the past 20 years had been due more to the last two factors than to any legislation. There is welcome evidence, however, that the present Manipur Administration is keenly interested in preserving the species; and the authorities deserve praise for steps already taken in creating and developing Keibul Lamjao Sanctuary. The new Public Works Department and Forest roads have made the sanctuary accessible by car. There are plans for re-afforestation of the small hills at the south-west corner of the sanctuary, and to construct a bungalow there for visitors.

In view of the fact that visitors have very little hope of seeing the deer in the sanctuary owing to its impenetrable *phumdi* conditions, there is a proposal to make an enclosure consisting partly of *phumdi* grassy area and partly of high ground grassy area near the site of the proposed bungalow (see Map 3). It is also proposed to re-afforest some of these over-grazed areas with *Salix tetrasperma*, a tree which is indigenous to these parts.

The above appears to be an excellent idea, especially as Brow-antlered Deer are known to do well in captivity. But it is questionable whether it would be in the best interests to have the enclosure at this place at the edge of the sanctuary, or to have it nearer Imphal—or even in the town of Imphal itself, in the form of a small zoological park.

With this latter view in mind, I accompanied the Chief Forest Officer to inspect two possible sites: One at Lamphelpat three miles from Imphal appeared unsuitable; but another possible site in Imphal near the D.M. College and next to the Imperial War Graves Cemetery on the main road from the airfield seemed to be a good one, as it consists of undulating grassland with some trees for shade. A third possible site, near Bishenpur where a botanical garden is proposed to be made, was also discussed.

Here it may be mentioned that Browantlered Deer have done well in captivity in various parts of the world. At Woburn Abbey, for example, the Duke of Bedford (1949) found that the species 'does quite well in confinement and with care could be preserved . . . Although several fawns were bred at different times, the herd received insufficient care and attention and was much reduced by 1914, when the war sealed its fate.'

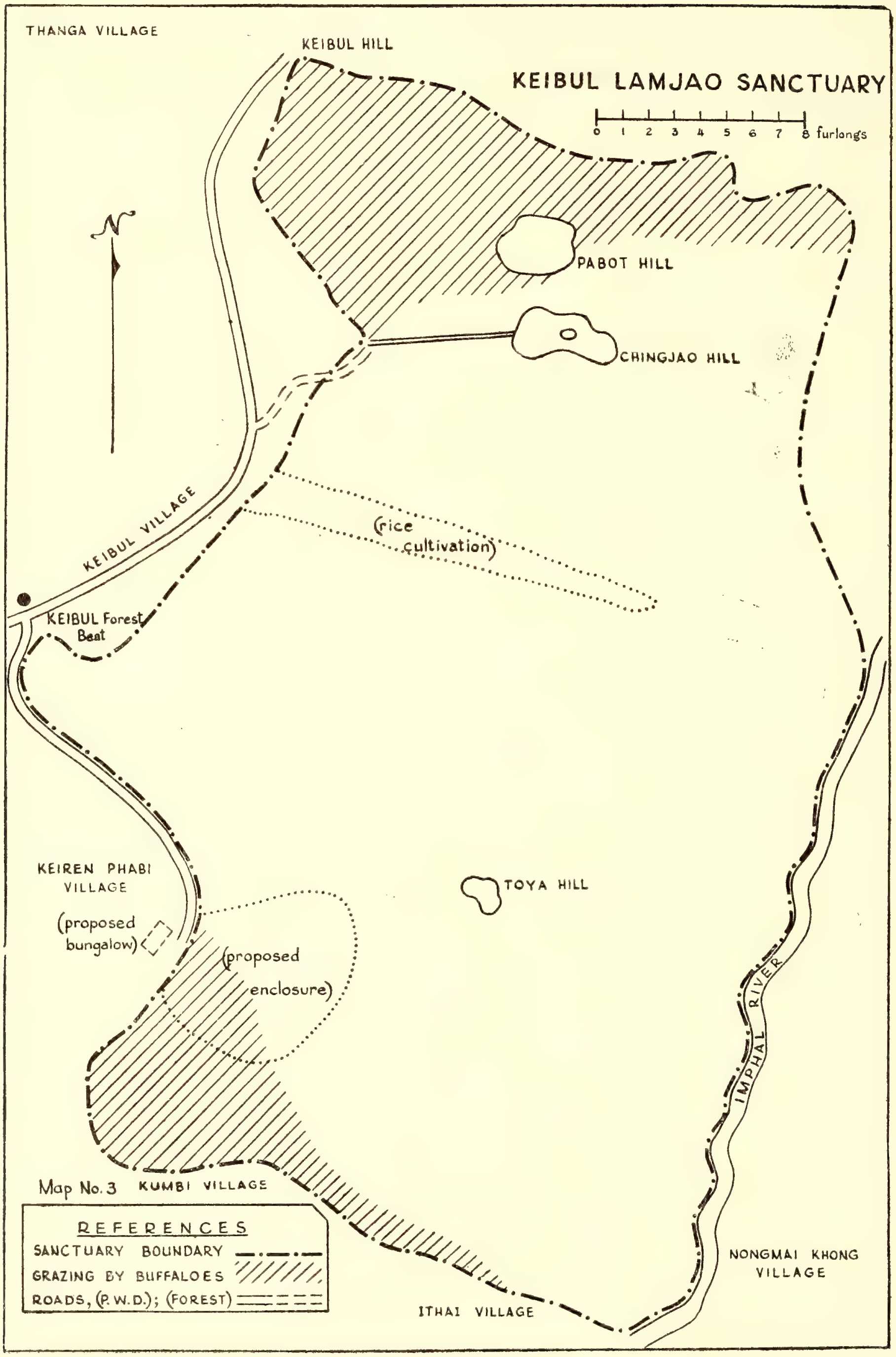
In the Regent's Park Zoological Garden of London, four fawns of Browantlered Deer were born during the years 1922-25.

In the Vincennes Zoological Garden of Paris a pair of the Thailand subspecies, *Cervus eldi siamensis*, obtained in 1937 multiplied to eleven by June 1954 when I saw them. They were in very good condition and were a very beautiful and graceful exhibit. Spots were still just visible on some of the adult animals. M. Nouvel informed me that the young are usually born in October and November, and that the period of gestation is 239 to 256 days. Maximum age recorded is 13 years. Stags commence to grow their antlers in August, and are in hard horn in December and shed their antlers in July. They mate in February. At the time of this report (July 1960) these deer in this zoo were 10 in number (2 stags, 5 hinds, and 3 fawns).

In the Rangoon Zoo, a pair of the Burma subspecies, *Cervus eldi thamin*, was presented in 1947 and by 1955 had increased to nine. In May 1960 there were ten of this subspecies still in this zoo.

In the Alipore Zoological Garden, Calcutta, deer believed to be of the *Cervus eldi eldi* subspecies did very well, and many fawns were born, in the years before World War II. In 1956 a pair of young animals was captured in Manipur and sent to this zoo, where fawns were born in October of 1958 and 1959.

It appears that stags of this deer, owing to the long brow-tine, are particularly susceptible to injuries—especially in the head. There have been several cases of this in the Rangoon Zoo. Even in the wild state this is the case, and Lt.-Col. Stockley (1928) wrote: '. . . the stags are most pugnacious, many being found blind of an


THANGA VILLAGE
KEIBUL HILL
KEIBUL LAMJAO SANCTUARY
0 1 2 3 4 5 6 7 8 furlongs
N
PABOT HILL
CHINGJAO HILL
(rice cultivation)
KEIBUL VILLAGE
KEIBUL Forest Beat
KEIREN PHABI VILLAGE
(proposed bungalow)
(proposed enclosure)
TOYA HILL
IMPHAL RIVER
Map No. 3
KUMBI VILLAGE
REFERENCES
SANCTUARY BOUNDARY
GRAZING BY BUFFALOES
ROADS, (P.W.D.); (FOREST)
NONGMAI KHONG VILLAGE
ITHAI VILLAGE

eye when shot. This is probably due to the position of the brow-tine. I once shot a stag which was entirely blind in both eyes.'

VIII. RECOMMENDATIONS (see Map 3)

The following recommendations are made:

(1) That the Keibul Lamjao Sanctuary be strictly protected as the only remaining habitat of the very rare Manipur subspecies of the Browantlered Deer. The following measures in particular are advised:

(*a*) Rice cultivation in the centre of the sanctuary should be prohibited.

(*b*) The question of the waste land on the western side of the sanctuary, at present unlawfully occupied by villagers, should be settled in the best interests of the sanctuary, and so as not to antagonise the local villagers.

(*c*) The grazing in the sanctuary of domestic buffaloes, if it cannot be prohibited, should be restricted as much as possible. The possibility of excising some of these grazing areas from the sanctuary area could be considered.

(*d*) Fishing and cutting of reeds in the sanctuary, if an established right and not preventable, should be carefully watched so that there will be a minimum of danger and disturbance to the deer.

(*e*) The numbers of wild pig should be reduced, when they raid the neighbouring rice crops.

(2) That the Forest Staff in charge of the sanctuary should be as permanent as possible, and under an officer of a rank not less than Deputy Ranger.

(3) That an ecological study be made of the deer in its unusual *phumdi* habitat.

(4) That, owing to the extreme difficulty of seeing the deer in the sanctuary, a few animals be humanely captured (departmentally) and kept in a suitably located enclosure. This measure should assist in preserving the animal, in increasing its numbers, in enabling scientific study, and in providing an attractive exhibit for visitors.

(5) That the Game Rules, published in 1958 as 'Preservation of Wild Life in Reserved Forests and other parts of Manipur', be revised and brought up to date.

(6) That steps be taken to ensure education and publicity in wild life and nature conservation, in order to arouse consciousness among the people of the cultural and economic value of wild life.

IX. Acknowledgements

Finally, I must offer my thanks to those officials and non-officials without whose interest and help my survey would not have been possible. The Chief Commissioner and the Deputy Commissioner both showed keen interest in the subject of preserving the Brow-antlered Deer, and both attended when I showed some cine films of Indian and African wild life. Mr. Goweahari Singh, Secretary (Miscellaneous) to the Manipur Administration, showed great interest in what I was doing, and paid a visit to Moirang in order to discuss sanctuary and preservation matters with me. Mr. S. Gambhir Singh, Chairman of the Imphal Municipality, was extremely kind and hospitable on every occasion I met him at the Manipur Hotel.

In particular I want to offer my thanks and appreciation to Raj Kumar Bijoychandra Singh, Chief Forest Officer of Manipur, who from the very start made all arrangements for my visits and assisted me with information and practical help in the way of transport and men to accompany me. To his subordinate officers—Rangers, Foresters and others—I also owe a debt of gratitude for all help rendered.

X. Glossary of Local Terms

Beat: (1) in forests, a sub-division of a Range, or (2) in shooting, a patch of jungle which is beaten for game, or (3) the actual beating of the forest for driving.

bil, bheel: small shallow lake (in northern India): see *jheel.*

chaprassi: a messenger or other such servant.

ching: hill.

huithou: wild dog.

ishing kombong: tall grass in water in sanctuary.

jheel: small shallow lake (in India): see *bil, bheel.*

kharsa: hog deer.

khoimum: tall reed grass with white tuft.

khunou: new village.

lamoak: pig.

loo: basket trap for fishing put down through holes in *phumdi.*

loukon: group of paddy fields.

lousang: small shed in paddy fields, for driving away pig.

mahal: an area (of forest etc.) leased out to contractors for commercial exploitation.

maril: course, way.

monsoon: annual rainy season.

pat: lake.

phumlen thangol: implement 7 feet long for cutting *phum* (*di*).

phum, phumdi: mat of organic matter, humus, in which reeds and grasses grow. (*P. arupa* sinking type, *P. ataoba* floating type.)

pulai: a plant (pigs eat it).

Range: a sub-division of a Forest Division, which contains a number of Beats.

Range Officer, Ranger: the Forest Officer in charge of a Range. (Deputy Ranger is next in status.)

sangai, shangai: Manipur subspecies of the Browantlered Deer, *Cervus eldi eldi* McClelland, 1842.

shabeng: goral.

shajan: sambar.

shaji macha: barking deer (lit. small deer).

shamu: elephant.

shikar: shooting, sport.

shikari: a sportsman who shoots, or a tracker for sportsmen.

singnang: grass in sanctuary.

singut: tall reed with brown tuft (cut and used).

thamin, thameng: Burmese for the Burma subspecies of the Browantlered Deer, *Cervus eldi thamin* (Thomas) 1918.

tou: tall reed (taller than *singut*) with brown tuft (cut and used).

turen: river.

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Some Notes on Sanctuaries and Wild Life in South India (1959)

BY

O. H. DE ST. CROIX

Anyone now (January 1959) revisiting the Nilgiris after a lapse of 15 or 20 years cannot but be struck by the transformation that is overtaking the whole scene, particularly on the plateau itself. During and since the last war, there has been a steady increase in the area of land brought under vegetable cultivation, with its accompanying unsightliness. Natural forest cover is giving way to extensive tea, wattle, and eucalyptus plantation, and there is nothing uglier in the whole field of silviculture than eucalyptus farming as practised in the Nilgiris. Most important of all is the dam construction, both in hand and prospective. This in a few years' time will transform the higher parts of the plateau into a lake district, submerging many of the valleys formerly noted for their natural scenic beauty. The catchment areas of some of these reservoirs have already been very extensively afforested, also with wattle and eucalyptus. Thus, far and wide the characteristic and traditional Nilgiri scenery of downland and shola will soon have disappeared. Perhaps it will only be visible in the unspoilt natural state in the most inaccessible places and in those localities where special steps have been taken for its preservation. It is understood that some such steps have been taken to preserve the Wenlock Down area, the views over most of which are still refreshingly natural. But it is sad to find that there is already some infringement on what used to be one of the finest examples of a typical Nilgiri landscape, namely the view from the terrace of the Ooty Golf Club. Here the expanse of rolling downs and sholas spread, with scarcely a human habitation visible, as far as the eye could see on either hand, and receded into a distant background of higher peaks fading range after range in perspective. On a fine evening, with the setting sun breaking in slanting golden shafts through a scattered ceiling of cloud to throw a patchwork of light and shade over all, this was a view of unforgettable beauty. Now the squares of bare earth and red-tiled roofs, which denote the advent of vegetable cultivation, have started to creep in from both sides of the picture and the gaunt outlines of mutilated eucalyptus trees have begun to introduce the usual disfigurement. It is a pity, because this characteristic Nilgiri scenery, and this particular view in itself, was a great attraction to the visitors on whom Ooty thrives. One cannot help wondering whether, if most of it is destroyed, the inhabitants of Ooty and the Nilgiris will not have lost more than they have gained by destroying it. Also, is it really necessary to destroy most of it?

However, some developments of this sort are only to be expected as a result of the relentless pressure of expanding population from down below. Without doubt, they are for the greater part in the widest interests of the nation and, as such, one can only take exception to certain details of their implementation. The fact has to be faced that, in a few years' time, the aspect of the Nilgiri plateau or a very large part of it will be transformed. It will then be largely a region of chequered cultivation, man-made plantations, and artificial lakes, surrounded by afforested hills. Much of it will be opened up for the first time by a network of newly constructed motor roads with their accompanying infusion of 'civilisation'. So in due course any remaining tracts of natural scenery will probably be regarded as museum pieces.

Whether most of these changes will be for the good or not scenically is a matter of taste and opinion. Certainly, they will make for an interesting study in ecology which should well repay any research put into it. For when the hand of man is busy altering the face of the earth so intensively it is bound to have a pronounced impact sooner or later on the local fauna. Existing species may find the new conditions uncongenial and dwindle in numbers, or possibly even change their habits; species not at present represented may find the conditions to their liking and move in. There may even be scope for interesting (but one hopes cautious) experiments in the introduction of new species, particularly fish. All this should provide an absorbing and rewarding study in about 5 to 10 years from now and thereafter.

Meanwhile it is pertinent to take note of the current position of wild life on the Nilgiri plateau. It is a region which by its very nature cannot ever have supported the larger mammals in any real numbers; evidently, also, their numbers have always fluctuated considerably with the seasons and the local conditions. However that may be, the expansion of the human population and of the cultivated area has undoubtedly reduced the natural stock to a pitifully low level today. From all sides one hears that the existing protection laws have failed signally to check the inroads of poaching. It is arguable that they have also failed to afford the necessary protection through legitimately controlled shooting or fishing. To this there is one exception in the case of the Nilgiri Tahr (*Hemitragus hylocrius*) the protection of which appears to have been a notable success. But, in fairness, it must be conceded that both its habits and its habitat lend themselves to artificial protection; for it is an animal well able to look after itself, with natural haunts so far removed from human habitation as not to infringe on cultivated land and to attract the attention of only the most ardent shikari. Apart from the one case it cannot be denied that the present status of the larger and more interesting mammals is an extremely dismal one. What of the future? Unless there is a radical improvement in the efficacy of the protection laws and the efficiency of their enforcement, there seems little hope of improvement. It will be a great pity if something sweeping and imaginative is not done in the direction and done soon. For, to balance the spread of cultivation and the clearance of sholas, the extensive afforestation already referred to should eventually provide an over-all increase in the area of cover available for the larger animals. Whether all this artificial growth will be suitable to the needs of the native fauna can only be determined in the course of time and assessed by expert observation. If results are favourable the usual clash with the interests of agriculture and of stock farming will certainly arise. But to a great extent the newly afforested areas are fairly remote from cultivation and it should be possible, with properly framed and enforced laws and intelligent administration, to strike a happy balance between the requirements of the naturalist and the sportsman and those of the farmer.

As regards birds, here again the plateau is a region which does not freely support the larger species. But it is, or could be, a most interesting field for the observation of a large number of the smaller ones, varied and augmented as they are from time to time by local and long-distance migration. At the present time there is one species above all which forces itself on the attention of the visitor, namely the Jungle Crow (*Corvus macrorhynchos*). It is so noticeably abundant as virtually to replace the common House Crow (*Corvus splendens*) of the plains, both as a scavenger in the urban areas and as a forager in the country. From the ornithological point of view this is a sinister fact; for there can surely be no species so destructive to other and useful birds in the nesting season. One cannot help wondering at the beneficial effect on the useful bird population of the Nilgiris that would result from a drastic control of the Jungle Crow and all his works.

Of game birds, both the variety and numbers are strictly limited. Despite the presence of much and widely dispersed bog land, the occurrence of snipe (*Capella gallinago*) cannot be described as more than occasional, at least as the snipe population is reckoned in other parts of India. Where there has been inundation on a large scale, waterfowl of all kinds are conspicuous by their almost total absence. From this it can only be concluded that there is something lacking so far as birds are concerned in the water-borne food supply of the Nilgiris. So the prospect of the creation of a number of new lakes does not appear to hold out any promise for the future in this direction. The real target for the small game shikari in the Nilgiris is the Grey Junglefowl (*Gallus sonneratii*), which is both resident and locally migrant, and Woodcock (*Scolopax rusticola*), entirely a long-distance migrant. The changing conditions are hardly likely to favour the latter since the clearance of sholas will restrict the haunts suitable to their highly specialized needs and the increased incidence of human disturbance is likely to discourage them. For Grey Junglefowl, on the other hand, the spread of afforestation may possibly be beneficial. But, under the most favourable conditions, the status of both species can hardly in the nature of things become one of abundance. In addition to coping with their natural enemies they cannot be expected to stand up to concentrated and unrestrained shooting. Hence, unless intelligently-framed protection laws are effectively administered, they are bound to suffer even further depletion.

The present sadly depleted status of these game birds is sufficient evidence of the ineffectiveness of the existing laws and their administration. To the visitor these appear to consist of more fees to be paid and rules to be read than there are game birds to be pursued, while the means for enforcing all these regulations properly are very far from being apparent. To this day the writer, who scrupulously observed all the rules on his one and only fruitless outing, has not received back the deposit paid about a year ago as a guarantee for observing them. There may still be worthwhile sport for the local resident who has access to private land and who knows his way about intimately and the pitfalls to be avoided. But it is not a form of sport to be recommended for the visitor as things stand at present.

What the Nilgiri game laws lack in efficiency they try to make up for in comprehensiveness. But even if there did exist the wherewithal to enforce all these rules and regulations it is doubtful whether they would be effective. This is because they lack proper provision for controlling the frequency with which an area of land is shot over or a stretch of water fished. For the type of shooting and fishing with which the laws are concerned this is surely an absolutely essential requirement. At present there is apparently nothing to prevent a stretch of trout water which has been showing good results from being fished all day and every day by any number of rods indefinitely. This is undoubtedly a major cause of the trout fishing standard in most of the Nilgiri streams having sunk to its present abysmal depths. The same would apply to the junglefowl shooting.

If the country were to be divided into shooting blocks and the trout streams into fishing beats, and permits issued accordingly in line with the needs of conservation, it should be possible with adequate administration to exercise complete control of frequency on public lands and waters. This is a system which has worked very successfully for shooting in the reserved forests of the former Central Provinces and Bombay Presidency and for trout fishing in Kashmir, and there seems no reason why it should not be equally successful in the Nilgiris.

* * * *

When the main Mysore Road leaves the rolling, open downland of the Nilgiri plateau it starts the descent by curving and undulating through an area of thick, low-growing natural forest. It then emerges suddenly on the very edge of the mountain range to disclose a startling panorama over a drop of some three thousand feet with a horizon scores of miles ahead and on either side. This view on a clear day must have few equals in India, or anywhere else for that matter. At this point the Nilgiri Range descends, with a few rocky outcrops, almost sheer to the Mysore plain below. From its foot there spreads out an uneven green carpet of thick forest as far as the eye can see, to a backdrop of jagged peaks hazy in the far distance. Clinging to the escarpment's edge the motor road proceeds in serpentine fashion along the gentle gradients afforded by a well-planned alignment, through patches of forest and cool coffee plantations, until it suddenly unfolds into the straggling village of Gudalur. From there it pursues a comparatively straight and level course, but now through stands of the most luxuriant forest. At first massed clumps of giant bamboos overtop the road, their outlines plumed and feathery. These soon give way to thick tangles of vegetation presided over by towering evergreen trees partially excluding the light and imparting rather a sombre atmosphere to the scene. A cloistered silence prevails and there are few signs of life. All this betokens heavy rainfall and an abundance of retained moisture. But presently, as the climatic influence of the mountains recedes, a lighter, more open, and partially deciduous forest supervenes. Here at this time of day the only evidence of wild life is provided by frequent parties of langur monkeys (*Presbytis entellus*), feeding confidently along the roadside. But it does not require much imagination to realise that this whole tract of forest is an ideal habitat for almost the whole range of India's big game. In fact one is actually passing through the areas reserved by both the Mysore and Madras Governments for their wild life sanctuaries. The immediate objective is the rest-house provided by the Mysore Government for viewing its sanctuary of Bandipur.

BANDIPUR

The group of rest houses at Bandipur is ideally situated for their purpose, since although they lie within sight of the main road, only a few minutes' transportation takes the visitors into the heart of the forest. For transport the choice lies between a motor vehicle and elephant back. To have the best chance of seeing what one has come to see in the limited time available it is as well to try to cover as much ground as possible at the most likely times of day, namely early morning and late evening. So the choice inevitably falls on motor transport and instructions are given accordingly. Punctually, when the sun is well down towards the horizon, the vehicle presents itself. But it is very different from what was expected, being nothing other than an ordinary and rather elderly, light, commercial truck. It also carries an unexpectedly large crew, whose duties in relation to the job in hand are by no means clear. However, the expedition starts with a roar and a jerk and without much undue delay. Almost at once all traces of civilisation are left behind and the fruits of conservation in the shape of a plentiful stock of peafowl and jungle-fowl become apparent. But it also becomes apparent that the springs of the transport vehicle, if indeed there are any, have become well flattened out by violent use and abuse. The way lies over rough forest tracks which, though comfortable enough for a well-sprung passenger car, cause the truck, driven at some speed, to buck and sway like a launch in a choppy sea. Furthermore, the seating accommodation, which consists of hard, backless benches placed unsecured in the body of the vehicle, shows itself ill-suited for the purpose by bouncing and sliding about uncontrollably. Presently, the first herd of Chital (*Axis axis*) comes into view. There is much excited, but commendably silent, pointing by the crew. The brakes are jammed on firmly, causing the passengers and their benches to concertina quite indiscriminately against the driver's cab. The chital seem quite used to this sort of thing and continue grazing unconcernedly under the leadership of a finely antlered stag, their sleek dappled beautifully proportioned forms well shown up by the last rays of a setting sun. But this enchanting scene is quickly obscured by the truck's own cloud of dust catching up with it on a following breeze. So the expedition proceeds, bumping and rattling as before.

For the most part the forest is light and open, with many of the deciduous trees bare, thickened here and there by clumps of bamboo, and interspersed with grassy glades. There are occasional pools of water, on almost every one of which a pair of Spotbill Duck (*Anas poecilorhyncha*) is to be seen, thus showing how conservation of this kind can help preserve some of the larger indigenous game birds as well. But as a whole this tract of forest becomes too dry, soon after the monsoon is spent, to support the Elephant (*Elephas maximus*) and Bison (*Bos gaurus*) which every visitor comes to see and they have moved elsewhere for better grazing. Yet, as the truck winds over the many miles of track with which the Bandipur Sanctuary is provided, it is clear that a very satisfactory number of Chital (*Axis axis*) and Sambar (*Cervus unicolor*) is maintained. Also, their tameness is a tribute to the efficiency with which the work of conservation has been carried out.

Next morning, after a Spartan night spent on wooden plank beds, each as hard as a sacrificial slab, the expedition is repeated. The results are very much the same so far as the viewing of animals is concerned. But what is lacking in the variety of wild life is compensated to a great extent by the charm of the scenery. At this time of day the forest is lightly clad in early morning mist. This vanishes as the sun gains in power to reveal the wildness of the surroundings in a soft glowing light and the full grandeur of the Nilgiri Range rising abrupt and clear-cut from the horizon only a score or so of miles away.

For this excursion the visitors, their posteriors by now well chastened by the continuous impact of the unyielding benches, prefer to stand most of the day. With little on which to grip, this is not only a severe test of one's balancing powers, but involves the risk of being suddenly swept off by an overhanging branch or catapulted into the surrounding forest by an unexpected heave of the truck.

After a time, with the magic of early morning dispelled by the harsh light of day, this sort of progress begins to pall. A distant view of the rest house is quite welcome, especially as breakfast is known to be waiting there. Then, as if by way of a parting present, the forest with almost its last opportunity reveals a superb, lone sambar stag. Hearing the approaching noises it had paused frozen in its tracks to investigate. It stood stock still in a small glade only a stone's throw away, gazing back over its shoulder with its ears pricked forward in curiosity and its muzzle upraised as if to ease the burden of the thick, branching antlers. Soon it sensed the presence of humans and melted almost imperceptibly into the forest background, leaving behind a memorable impression on the minds of its viewers. The latter, though stimulated by this wonderful sight, disembarked a few minutes later with some relief. By now, they had that well-churned-up feeling which one usually associates with a session on one of those mechanical horses to be found in a ship's gymnasium.

MUDUMALAI

The next objective is the Mudumalai Sanctuary maintained by the Madras State, whose boundary marches with Bandipur only a few miles down the main roads on the way back to Gudalur. Although much the larger of the two in area, Mudumalai is apparently not well served by motorable tracks. So an evening excursion on elephant back is arranged. Incidentally, the camp of the Forest Department's working elephants is one of the most interesting sights in this area and, being located by the side of the main road, is easily accessible. But on this occasion all its occupants were still out on the day's work except one large, rather somnolent female with a very young and frisky calf at heel. There is not time to do more than strike up a passing acquaintance with these two since the riding elephant is already kneeling ready to receive its passengers at the rendezvous just up the road. In a very short time the party is mounted and away in the thick of the forest. And then the main advantage of an elephant ride over motor transport is at once apparent. For the way is now right off the beaten track, through the densest forest, up and down steep inclines and across unbridged watercourses. A steady, unhurried pace is kept up throughout regardless of the terrain. Being nearer the treetops there is ample time and opportunity for observing the smaller forest inhabitants such as birds and butterflies and also several giant squirrels whose habitat is only a little above eye level by this means of transport. The forest here is of a very different type to that at Bandipur. There is an abundance of lush grazing, a preponderance of evergreen trees, patches of dense undergrowth, frequent clumps of gigantic bamboos, and a sufficiency of water—in fact everything, seemingly, that should go to attract and support a good stock of elephant and bison. But, unfortunately, although there are many recent traces of the former, not one of either species is encountered in the limited compass of an elephant ride during the two hours or so before sunset. Such a brief excursion must always be chancy of results. Yet, even if nothing in the way of big game is to be seen, a ride on elephant back can never be really dull if one takes an interest in the behaviour of the mount itself as it makes a bee-line through every obstacle the forest can present. For an elephant moves its massive bulk with such fully articulated precision as to be fascinating to watch. The result is a smooth, silent, deliberate progress which gives the impression of every movement being carefully calculated, of perfect control over immense power, and of a capacity for almost unlimited endurance. There can be little doubt that the elephant is one of nature's most efficient products as well as one of her largest.

This one fills in the time and his stomach by nonchalantly plucking titbits from right and left without checking in his stride and stuffing them into his mouth, to be consumed voluminously as he continues on his way. Thus he makes a good meal without incurring the displeasure of his mahout, and finishes much more contented than his rather disappointed passengers, when the cavalcade returns to the starting point just as darkness falls.

After seeing these two sanctuaries a thoughtful visitor cannot help raising the question of how far they have been successful in achieving the objects for which they were instituted. What in fact are the main objects? There is first and foremost the object of pure preservation and in this it can be said at once that considerable success has been achieved. But almost equally important is the object of enabling the wild life thus preserved to be viewed and studied with reasonable facility and comfort by visitors, particularly foreign visitors, by which term I mean ordinary visitors and not those coming on a V.I.P. basis. For this purpose it seems fair to say that current arrangements do not go nearly far enough. In fact it appears that a golden opportunity is being missed to enlarge on this, and the following is intended as a constructive commentary from a foreign visitor's point of view.

In the first place there is the question of the way in which the sanctuaries themselves are at present constituted. It is understood that the Bandipur Sanctuary is only between 20 and 30 square miles (52 and 78 sq. km.) in extent. One hears that shooting is still allowed in its immediate neighbourhood and, on very special occasions, even the sanctuary itself. If this is so it seems a great pity and is difficult to understand. But even more surprising is the fact that the Mudumalai Sanctuary, although immediately adjacent to and part of the very same forest tract, is operated as a completely separate concern. This is because the entirely artificial political boundary between Mysore and Madras States happens to run through this forest area and each State apparently has to control its own sanctuary. Surely in a matter like this local political outlooks can be stretched to a broader national view, and an amalgamation effected into one centrally administered whole. It would of course vastly enhance the value of the whole project if in doing so the total area of the unified sanctuary could be suitably increased to about 300 sq. miles (780 sq. km.).

Then there is the question of the actual viewing facilities for visitors. Most of them are likely to have only a short time available. In such circumstances the best chance of seeing something worthwhile is by covering as much ground as possible during the most promising times of the day, which add up to a very few hours in all. This makes motor transport essential and presupposes that the whole sanctuary area is covered by an adequate network of motorable tracks. And there seems no reason why this should necessarily involve extreme discomfort. A freight truck can by no stretch of the imagination be held suitable for the purpose, particularly if special seating fitments are not provided. The noise alone that it makes goes a long way to defeat its purpose. The commoner animals, more accustomed to the presence of man, have evidently got used to it. But this may account for the fact that tiger and panther are so seldom seen by visitors. With their extremely acute hearing they can detect one of these approaching excursions from a great distance and make themselves temporarily invisible with the utmost ease. A jeep-type vehicle is surely the most suitable for this sort of work and two or three of them at the outside would cover all present needs. Also there seems no real reason why visitors so willing should not be allowed to take out their own cars if escorted. At the same time it should be remembered that in the world of Indian fauna the greater activity happens at night. By far the best way of viewing nocturnally is by construction of an elevated observation post over a water-hole on the lines of Tree Tops in Kenya. It need not be unduly elaborate, but in this forest would certainly have to be insect-proof. All this should not be taken to suggest that excursions on elephant back should be eliminated. They should certainly be retained, as a supplementary means of transport for those with more time at their disposal, or who are more interested in a close and leisurely study of the smaller forms of forest life, or who are intent on photography. Since in any case the Forest Department's working elephants are maintained here, this should not be difficult to arrange. Another aspect of this whole matter concerns the best means for ensuring that animals are attracted permanently to the sanctuary enclave in sufficient numbers and remain there as evenly spread as possible over the entire area. For at present there tends to be a distinct local migration in the dry season to follow the best grazing. The most likely means for dealing with this problem would appear to be the formation of more water-holes, the provision of artificial salt licks, and even suitable planting, if and where possible, in the drier zone of the sanctuary.

Finally there is the question of accommodation for visitors. At present this is about the most unsatisfactory feature of all. To begin with, application has to be made to a separate authority, each at a different place, for each sanctuary, with the added annoyance more often than not of dilatoriness in reply. As for the accommodation itself, at Bandipur it consists of three separate units at some distance from each other in a large cleared area. The largest of these is understood to be the former State shooting lodge, a portion of which still seems to be reserved for official purposes. That part of it which is available to the public is more suitable as accommodation for large family or other such parties than for casual visitors. The second unit of accommodation, the Forest Rest House, while well built, well situated, and clean, seems designed primarily to house officials on tour and is far from convenient for a number of visitors arriving in ones or twos and strangers to each other. The third unit, again situated at some distance from the other two, was at that time not yet ready for occupation. So far as could be seen it comes much nearer to actual needs in that a row of small bed rooms, each with a bathroom and a verandah, is provided.

But what should really be provided for a requirement like this is a compact arrangement of buildings on the hostel system, with a number of small double suites attached to a central lounge, dining room and kitchen. This would give not only the most suitable but also the most economically administered accommodation. At present even basic food requirements such as rice, vegetables, eggs, and milk are very difficult to obtain. If the supply of these could be organised, it would save visitors the inconvenience of bringing perishable foodstuffs as well as tinned stores.

At Mudumalai, a new rest house has recently been completed, the design of which is much more suited to the needs of the case and it is well situated to command a wonderful view over the forest towards the Nilgiri Range. But the number of rooms available seems inadequate, if the requirements of touring officials have also to be taken into account, in addition to those of visitors.

There is one more point on this subject of accommodation, a small one admittedly, but worth mentioning in the general context. Surely the interiors of rest houses in a wild life sanctuary are not suitable places for a display of trophies of the chase or of V.I.P.'s on shikar posed in front of their latest victims. Here more appropriately is an opportunity to display, suitably enlarged, some of the wonderful photos that have been taken of the living wild life to be found in this forest. In addition to their aesthetic value they would serve to promote the cause of conservation and also help uninitiated visitors to identify the various species which they are likely to see.

When it is time to leave this attractive and largely unspoilt forest, the return journey to the Nilgiri Hills is started with some reluctance. As the road climbs back to the plateau there is again revealed that wonderful panorama over the treetops just left behind. The visitor with an enquiring mind cannot help but feel that he has been shown only a part of what there really is to see. His disappointment is perhaps tempered by the hope that surely the authorities may in the not very distant future develop the full potential of this most interesting region as both a show place and field of research for the naturalist. In so doing they will reveal the true value of a fine national asset and there will be an immeasurable gain to all concerned if they do.

PERIYAR

The long established and now widely known Periyar Game Sanctuary is remotely situated from most of the more usually frequented centres of population. Perhaps this is as well and may account for a good deal of its attraction. But when someone genuinely interested really wants to see it, the journey thither represents something of a problem for those not actually resident in the far south. However, for the intending visitor from the Nilgiris there is a very direct and scarcely known route which is of some interest in itself. This lies from the foot of the Mettupalayam Ghat straight across the intervening plain to a locality where the foothills of the Annamalais and the High Range converge. From there a little used and rather neglected road starts to climb, at first gradually, then steeply, but always tortuously, into the hills. Very soon the asphalt surface, cultivation and other signs of a settled area are left behind. For several miles, the way is through a zone of scanty rainfall with resulting ragged scrub-jungle and scraggy deciduous forest. At times the road clings giddily and without a parapet to the sides of precipitous slopes with a drop of many hundreds of feet on one side. Quite suddenly, it straightens out somewhat into more fertile and well-favoured valleys and the first tea plantations appear. Finally another steep climb up and over, debouching into scenery reminiscent of Scotland, brings the traveller after many winding miles to Munnar, the capital of the tea industry in the High Range. From there onward, the road leads through scenery of an entirely different character. Once the orderly green ocean of tea has been left behind, it plunges into a jumble of low hills and thick tangled forest, long stretches of which have been adapted to cardamom plantation. This is real elephant country. In some ways it would be the most interesting part of the whole trip if only the condition of the road gave the opportunity to enjoy the surroundings. As things are, it is quite a relief to reach Thekkady, the nearest inhabited place to the sanctuary.

The hostel on the Periyar Lake is self-contained in that advance booking can be accepted on the spot, comfortable and fully-equipped accommodation is available, and full feeding arrangements are provided. There is thus a vast improvement over the Madras/Mysore organisation in this respect alone. It is situated on the very edge of the lake which forms the core of the sanctuary and within a few minutes of arrival a launch trip is booked for the same evening. It merely remains to fill in the intervening time with rest and refreshment.

It is only a hundred yards (90 metres) or so from the hostel down to the landing stage. When the launch pushes off, the surrounding scene is flushed with mellow evening sunlight, most stimulating to the anticipation of prospects ahead. One does not have to go very far to realise why this is such an admirable place for viewing wild life. For when a dam was thrown across the Periyar River it formed not one vast expanse of open water, but a series of long channels reaching up narrow valleys through the surrounding hills. The result is that a boat is seldom more than a hundred yards or so from the shore on either side and anything near the water's edge is clearly visible to the naked eye. In places, towering, untouched forest comes to within a few yards of the lake with rich grazing along the verge. Elsewhere grassy slopes of varying steepness rise to a few hundred feet, their folds and gullies thickly wooded. The water channels wind and bend, so that it is frequently possible to get surprise views by coming round a corner suddenly without being seen. It is hard to imagine a more convenient arrangement for observation and all from the comfort of a launch. In these respects the Periyar Sanctuary must surely be unique.

But on this particular evening there is not much to be seen. Especially there is a strange absence of birds, and of water birds there are scarcely any visible at all. As the voyage gets well away from the inhabited end of the lake, sambar appear regularly, sometimes in numbers, grazing high up in the open. They seem to favour the extensive patches of burnt grass, presumably attracted by the lush new sproutings, but incidentally making themselves almost invisible against the dark background. The single master stag seen was lying down on one of these burnt patches and could only be spotted for certain by careful focussing with the binoculars.

A sharp turn leads to the dam itself, and the only sizeable expanse of open water. On the far side steep grass-covered slopes lead up to the highest peaks that border the lake. There is a large rock-like object protruding from the grass far up above the water here. Is it a rock or not? The binoculars seem to confirm that it is. But there is something unusual about it and further scrutiny by eye convinces that there has been some sort of movement. Again the binoculars are brought to bear and there is no mistake about it this time. It is an elephant all right—a flapping ear gives it away. It is standing knee-deep in grass, surrounded by such an abundance of food that it scarcely needs to move in gathering its evening meal. Now that the outline is familiar a second one is spotted, lower down and browsing at the edge of a thicket. The launch is stopped and for several minutes the party watch intently and unobserved. Then the dipping of the sun below the horizon warns us that it is time to go and the launch is turned homewards. The light is too poor now to see much but a glimpse is caught of a lone bull bison at the water's edge. He is very much alert and fades into the forest with an ease that is astonishing for so large an animal. Further on, there is a simultaneous though distant view of a herd of bison cows with calves and a large sounder of pig, all within sight of the Travancore State Lodge. It is dark when the landing stage is regained, Very early next morning the trip is repeated. It is half light when a start is made and ragged wisps of mist still cling to the higher parts of the forest; most of the peaks are shrouded in cloud. Over all there is calm and silence, broken only by the hoarse purring of the launch's engine. Ten minutes or so pass uneventfully and then, as if by arrangement, out of the forest just ahead and close to the shore, steps a magnificent bull bison. He is facing the other way, so has not seen, and somehow has not heard, the intruders. The driver has the sense to stop the engine at once and the launch glides silently under its own momentum almost level with the object in view. At a range of about 50 yards (45 metres) every detail of the bison can be observed, his huge, hunched shoulders and shapely hindquarters, the powerful muscles rippling under his sleek, chocolate-coloured hide, the smart white socks and twitching tail. Presently something prompts him to turn his head giving a view of the massive, curling horns. A brief pause and gaze, dilated nostrils, and then, not satisfied with what is to be seen, he is gone as silently and suddenly as he appeared. The party resume their voyage exhilarated and fully confident that this morning their luck is well and truly in. Yet although they cruise around far and wide for an hour or so nothing further of any sort is seen. So a course is set straight back to the hostel with all thoughts on the breakfast waiting there to the exclusion of everything else. Then, as often happens on such occasions, the sight for which they have been hoping and searching unexpectedly presents itself. In passing a long narrow inlet 3 elephants are spotted disporting themselves on the open shore. The helm is put hard over, speed is reduced, and the stalk begins. But the elephants have heard them and take speedy evasive action. To make up for this the launch comes suddenly on a party of cows with very young calves, all hitherto unseen on the opposite bank. These stand nervously huddled together in long grass, with upcurled trunks searching the air like some sort of radar equipment, and their offspring shielded by their bodies. The visitors are watching this interesting family scene when something much more exciting comes into view. At the head of the inlet on a wide grassy level, well away from the surrounding trees, stands a giant solitary tusker. Except for a gentle swaying of his trunk he stands quite motionless as if meditating on a full stomach and wondering what to do next. Against the background of sweeping grassland and wild forest, with distant cloud-capped peaks where the morning sun is just breaking through in downward-slanting beams of light, there is something primeval about this scene which stirs the imagination. The visitors watch enthralled until their departure can no longer be delayed, leaving the tusker to his thoughts.

What are the reflections on a visit like this to Periyar? The facilities provided for visitors go a long way to meeting justifiable requirements. At the hostel the accommodation, service, and food set quite a satisfactory standard. Nevertheless, the sleeping accommodation at present available could with definite advantage be supplemented by additional single and double rooms, which need not be large. There should not then be undue congestion with the arrival of sizeable parties in addition to the usual casual visitors. But is it necessary to have the windows of the hostel so heavily protected with thick, vertical, iron bars? In the larger rooms they give one the impression of being caged and in the smaller ones of being confined in a prison cell. The compound is already guarded by a special ditch sufficient to keep out most animals and it is understood that the additional window protection is to guard nervous visitors from over-inquisitive and perhaps hungry carnivora! If they really must be so protected there are several kinds of window guards on the market in artistically wrought designs which would be equally effective. Then again, although the hostel is well situated on a promontory overlooking the lake, it is completely screened by trees from an exceptionally beautiful outlook. This could surely be improved by judicious felling and clearance without in any way spoiling the scenery as a whole. Certainly the attractions of the hostel would be immensely increased thereby.

While the transport arrangements for viewing are as efficient and comfortable as one could reasonably wish, there would be a great improvement if the launch engines were to be fitted with silencers. This would much enhance the prospects of seeing the more wary animals, particularly the carnivora. At present too much depends on the driver's promptness and commonsense in switching off or throttling back when something comes into sight.

Finally, how efficient is the organisation for ensuring the actual protection of the wild life in the forest surrounding the lake? The visitor does not usually set foot on shore so it is impossible to see for one's self. If it is as efficient as the arrangements for protecting the visitors in the hostel, well and good. Yet there are disquieting rumours of rampant poaching. Certainly the behaviour of many of the animals seen, especially the bigger ones, indicated anything but confidence in human beings. Although on this particular visit almost everything was seen that one could reasonably hope to see in so short a time, reports from other visitors give the impression that this may have been due to pure luck. This should not be in a sanctuary with so perfect a setting and with such admirable facilities for viewing. One can only hope that the authorities concerned are fully alive to the need for the strictest, most efficient, and comprehensive enforcement of protection over the whole area. Otherwise what is, in its way, undoubtedly a national asset of the very greatest, and possibly unique, value will in a short time just wither at the roots.

Obituaries

S. P. AGHARKAR

The world of Science in India, and of Botany in particular, suffered a great loss early in September 1960 by the death at Poona of Dr. S. P. Agharkar at the age of 76.

Dr. Agharkar obtained the B.A. degree with Biology from the Elphinstone College, Bombay, and was placed in the first class. He also had the distinction of being awarded the Wordsworth Prize in English. Subsequently, he went to Germany, where he had the privilege of working under the famous botanist Prof. Engler. He obtained the Ph.D. degree with credit, but the outbreak of World War I prevented his return to India. On the termination of hostilities, he came home and was appointed Professor of Biology in the Elphinstone College. It is interesting to note that his earlier work was concerned with zoological problems, which included the discovery of the first freshwater medusoid in India, *Limnocnida indica* Annandale.

Dr. Agharkar was appointed Bose Professor of Botany in the Presidency College, University of Calcutta, where he worked for 25 years till his retirement in 1941. In recognition of his services to science, the Royal Asiatic Society of Bengal awarded him the Indian Science Congress Medal in 1944.

Dr. Agharkar was a man of varied interests. He has held the offices of President and Vice-President of the Indian Botanical Society. He was the General Secretary of the Indian Science Congress Association for several years, and enjoyed the unique distinction of being the President of the Botany Section of the Indian Science Congress twice. He was Vice-President of the National Institute of Sciences for a number of years, a member of the High Altitude Commission appointed by the Government of India for the investigation of flora, a member of the Managing Committee of the Indian Central Jute Committee, President of the Indian Ecological Society, etc. His accurate knowledge of the laws and by-laws of various bodies and institutions, and of constitutional rules, enabled him to render great service to all the bodies with which he was associated.

After his retirement from the Calcutta University, he settled at Poona, where he founded the Maharashtra Association for the Cultivation of Science on the lines of the Bengal Association for the Cultivation of Science. This Association has been tackling a number of problems relating to rice, fibre-yielding plants, mangoes, betel-nuts, bananas, etc., under schemes sponsored by the Central and State Governments. One of Dr. Agharkar's magnanimous gestures was the donation of his personal collection of rare books to the library of the Calcutta University, and of important books on Botany worth Rs. 60,000 to the Maharashtra Association for the Cultivation of Science. He joined the Bombay Natural History Society in 1908 and, though the membership lapsed during his detention in Germany, he rejoined in 1948 and served actively on the Executive Committee from 1954 until his death.

Dr. Agharkar was one of the most amiable of men, and his ever-present smile was an assurance of the joy with which help and advice were given to all who approached him. His dynamic personality will be missed by all scientists and particularly by botanists. By his death the country has lost a profound scholar, an indefatigable worker, and one of its prominent scientists.

B. S. NAVALKAR

C. H. DONALD

We are sorry to have to record the recent death of Mr. Charles Hilliard Donald at Dornoch, Scotland.

Born in India in 1873, Mr. Donald belonged to a family which has had a long association with this country. He was educated at Bishop Cotton's School in Simla and George Watson's College, Edinburgh. On his return to India he joined the Sutlej Forest Company of which he became the managing partner.

He joined the Society in 1896 and was actively associated with the first attempts at the preservation of wild life and fisheries in the Punjab and travelled widely in the Himalayas. In his younger days he was a keen falconer, and was perhaps the first person to have tamed and trained a golden eagle. His main interest was the study of the birds of prey and he contributed several valuable papers on this subject to the Society's journal—the last on 'The Flight of Eagles' in the special fiftieth volume.

He retired in 1932 but stayed in India till 1947. In 1945 he was elected an honorary life member of the Society in recognition of 50 years of keen and valued association with the Society.

In addition to his work on the birds of prey, he was also the author of a book on the training of gun-dogs, which hobby he continued after his retirement in England—his chocolate-coloured Labradors being wonderful examples of his patient training.

With his death we lose one of the oldest members of the Society and another link with the British residents who have done so much for the study of natural history in India.

We extend our heartfelt sympathies to Mrs. Donald.

EDITORS

STANLEY HENRY PRATER

(*With a plate*)

Stanley Henry Prater, whose name was almost synonymous with the Bombay Natural History Society for nearly a quarter of a century prior to his retirement from its curatorship in 1948, died in London on 12th October 1960 at the age of 70, after a long and crippling illness. He was born on 12th March 1890 in the Nilgiris (south India), the son of William Prater, a coffee planter. He was entered at an early age in St Mary's High School, Bombay, then conducted by Jesuit fathers of the German mission. From his early years most of his school holidays were spent at Khandala in the Western Ghats, and it was but natural that the first sparks of the boy's interest in natural history should be kindled by such surroundings. They were fanned into a steady flame by the sympathetic encouragement he received from the fathers, some of whom were distinguished naturalists. The main influences on his future career were those of Frs. Dreckmann (snakes), Assmuth (termites), and Blatter (plants). Them he always remembered and spoke of in later life with great reverence and affection.

Prater joined the Society's service in 1907, first working under the guidance of E. Comber, and later as assistant to the Society's first stipendiary curator N. B. Kinnear, afterwards to become Sir Norman and Director of the British Museum (Natural History). In 1923, Prater was appointed Curator of the Society and of the Natural History Section of the Prince of Wales Museum of Western India, Bombay. This position he held with marked distinction till his retirement in 1948 owing to his election to the Indian Constituent Assembly in New Delhi as a representative of the Anglo-Indian community, and the wholetime attention to politics and the frequent absences from Bombay that this would entail. To qualify him for the charge of a really first class natural history museum, worthy of the First City in India and of the Bombay Natural History Society, Prater was deputed by a far-sighted Board of Trustees in 1923 to the United Kingdom to learn the art of modern taxidermy in the studios of the well-known taxidermist L. C. Harwood. In 1927, he was again sent abroad, this time to the foremost museums in the United Kingdom and America, to pick up the techniques of modern natural history museum exhibition—the preparation of habitat groups or dioramas which, starting in Germany, had reached perfection in the United States, particularly in the American Museum of Natural History, New York, and what was then the Field Museum of Chicago. The fruits of his skill and aptitude are evidenced by the artistically designed galleries of the Natural History Section of the Prince of Wales Museum, Bombay, and the superb group exhibits, acclaimed to be the finest in the East.

This era of the Society, between the years 1923 and 1937, during which the new natural history wing was conceived, designed, erected, and opened to the public, was one of outstanding progress owing to the dynamic combination of two dedicated and far-sighted personalities, Sir Reginald Spence as Honorary Secretary of the Society and Chairman of the Board of Trustees of the Prince of Wales Museum, and S. H. Prater as his able and versatile executive. The Natural History Section is indeed a standing monument to Prater's genius. Not only the best use of his training abroad, but the gift he possessed for passing on the full benefit of his knowledge and experience to his co-workers and staff, and his tact and ability to extract whole-hearted co-operation from them, enabled him to achieve the highest results. He was fortunate in having an exceptionally competent and dextrous lieutenant in Charles McCann, who readily lapped up the imported techniques, adapted them to local conditions, and put them into masterly execution in the museum's galleries.

For the last 27 years of his service, Prater was the executive editor of the *Journal of the Bombay Natural History Society*. The high standard which the *Journal* attained during this period earned it international recognition as the foremost natural history journal in Asia. He was a voracious and discriminating reader, particularly of natural history books, in his early years. Reading, writing, painting and plaster modelling were his favourite hobbies during his retirement. The skill and discernment with which he would browse through heavy scientific literature, and the facile manner in which he would then connect up and expound disjointed facts, culled from many sources, and produce harmony from them were enviable. So was his rare capacity for picking out the essentials of anything he read, sorting out and assimilating complicated scientific data, and clothing the substance in simple, jargon-free language for the layman. He was blessed with a remarkably retentive memory, and could usually lay his hands on anything he had read on a subject, may be years before, without hesitation or fumbling. Prater excelled in the art of compilation ; he wrote in a readable, easy, and often humorous style, was a good illustrator with pen-and-ink or brush, and a frequent and welcome contributor of popular natural history articles to numerous journals and magazines. The bibliography of his principal contributions in the *Journal*, given below, conveys some idea of the wide range of his interests and versatility. The realization of

Stanley Henry Prater

the crying need for wild life preservation in India was brought home to the public and to the government largely by his able exposition in the introduction to the admirable series on Wild Life Preservation in India which he initiated in the *Journal* in 1935, and by his constant ' plugging ' of the problem through numerous well-informed editorials in the *Journals* and newspaper articles, before and since.

The familiarity he acquired with the Society's natural history collections during his long stewardship gave him a wonderful all-round grasp of Indian animals. Though his own leanings were more particularly towards mammals, birds, and snakes, he was quite at home with almost all other groups and could not only name straightaway practically any specimen brought in by members, even of the less common animals, but usually also give their distribution and habits. His intimate connection with mammals during the Society's Mammal Survey between 1911 and 1923, both as field collector and while handling the specimens as they came in from the field, or back from the British Museum after identification, gave him a particularly good knowledge of mammals. This, no doubt, accounts largely for the authenticity and success of his THE BOOK OF INDIAN ANIMALS published by the Society in 1948. During the mammal survey field work he suffered a serious accident which might well have cost him his life. A gun went off when picked up by the trigger by his local assistant and blew away a large part of his thigh. The injury, though it healed remarkably, incapacitated him for further strenuous field work, and from this time on his activities remained chiefly intra-mural.

Sir Reginald Spence first initiated him into politics so that he might be of service to his Anglo-Indian and Domiciled European community, then in need of able leadership. Prater took up his new avocation with his customary conscientiousness and gusto. The well-informed manner in which he handled all legislative problems, particularly educational, and participated in debates, whether concerning his own community or the public at large, made his opinions respected in government as well as opposition circles, and he was drafted on numerous important committees including the Provincial Franchise Committee and the Greaves Committee on Education. For 17 successive years he was the President of the Bombay Presidency Branch of the Anglo-Indian and Domiciled European Association, which he ably represented in the Bombay Legislative Council before Independence.

Among his other public activities, he was a member of the Provincial Board of Education, and of the Managing Committee of St. George's Hospital, Bombay, and a Justice of the Peace. In 1943 he was awarded the O.B.E. for meritorious services in various fields. His good standing and friendliness with persons of every shade of opinion, political and otherwise, and the confidence he commanded with the ruling party in the Legislative Council, were an asset to the Society from which it profited in many indirect ways.

Prater was, in truth, a remarkable man—capable, versatile, sociable, ambitious, and a striver after perfection as his many handiworks clearly show.

As friend, companion, and colleague, he was good natured and tolerant, and possessed of a keen sense of humour which never left him even in his last bedridden years. His sociable disposition and considerateness for his dependants and subordinates endeared him to all who came in contact with him. He will enjoy an honoured place in the Society's annals as one of its most stalwart and capable builders.

Appended is a list of the more important of Prater's contributions to the Society's *Journal*. His only book THE BOOK OF INDIAN ANIMALS illustrated by himself, is out of print, but a second edition is in preparation. Besides these, he wrote the section on the fauna in Percival Landon's NEPAL published in 1928.

S.A.

MAMMALS

1. Notes on Wroughton's Free-tailed Bat (*Otomops wroughtoni*). **22** : 788.
2. Note on a stranded Great Indian Fin Whale (*Balaenoptera indica*) at Ratnagiri. **23** : 576.
3. Progress of the Mammal Survey. **26** : 656, 1036.
4. An old time buffalo hunt. **27** : 627.
5. Record Panther Skull (*F. pardus*). **27** : 933.
6. The Tsaine. **28** : 786.
7. The Slow Loris (*Nycticebus coucang*). **30** : 215.
8. Measurements and weight of a Malay Tapir. **31** : 522.
9. The Dugong or Sea-cow (*Halicore dugong*). **33** : 84.
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Reviews

1. BORN FREE : A LIONESS OF TWO WORLDS. By Joy Adamson. Pp. 156 (24×17 cm.). 9 coloured and 104 black and white photographs and 1 map. London, 1960. Collins & Harvill Press. Price 25*s.*

The story of a pet—and what a pet ! A lioness, reared with the liberty allowed to a poodle or a peke. Neither fully tame nor fully wild, reared by human fosterparents on a game reserve in Kenya, Elsa presents a fascinating study. Joy Adamson, in her account of Elsa's growth to maturity and subsequent release, provides answers—frequently surprising ones—to all these questions : what are her reactions to her fosterparents, to her own kind and other animals, to life on her own ? Astonishing as it is, the account gives no impression of fabrication or exaggeration.

It is as sincere as it is straightforward. Lucid, direct, yet charming, the style of writing is simple. Which contributes to its width of appeal—to the natural historian, to the scientist, and to animal lovers of all ages.

The highlight of the book is the series of photographs, more fascinating, more convincing, and more astounding than mere words could ever be.

I.R.

2. COMMON MALAYAN BIRDS. By M. W. F. Tweedie. Pp. 69 (21.50×15 cm.). 20 coloured plates ; 7 figures in text by A. Fraser-Brunner. London, 1960. Longmans. Malayan Nature Handbooks. Price 12*s.* 6*d.* net.

This is a most attractive and handy little booklet. It is admirably designed for the beginner in bird study, as well as for the visiting ornithologist, and tells them in brief all they will wish to know about the hundred or so of the commoner birds likely to be encountered in Malayan towns and in the inhabited countryside ; how to recognize them, and something about their habits, nesting, calls, etc. A short introduction touches upon general topics, such as migration, the use of scientific names, and so on. Eighty species are illustrated in colour, in some cases showing both male and female, and there are 7 useful black and white sketches in the text besides.

This happy combination of author and artist, and the excellence of the printing, both coloured plates and text, is something of which every one concerned in the publication can be justly proud. If the other volumes of the Malayan Nature Handbooks are going to be as good as this, the series will indeed be an enviable one. It should go a long way to awakening that interest in Nature among the young which is so sadly lacking in most eastern countries.

S.A.

3. BULLETIN OF ENTOMOLOGY, No. 1. Pp. 1-41 (24× 17 cm.). Madras, 1960. The Department of Zoology, Loyola College.

We already have an entomological journal—the *Indian Journal of Entomology*. In addition papers on entomology appear in many other journals of a more general nature, including the *Journal of the Bombay Natural History Society*. The appearance of another entomological journal is therefore an indication that the output of papers on the subject has now increased to a point when existing journals cannot cope with them.

The first number has some distinguished contributors. Dr. M. L. Roonwal and Dr. B. P. Uvarov have both written appreciations of the work of Dr. Y. Ramachandra Rao, to whom this first issue has been dedicated. Dr. Rao published his first paper in 1910, and has continued publishing steadily to the present time. His outstanding contributions to locust research are known to every student of entomology. Dr. W. D. Hincks of the Manchester Museum has sent in a description of a new species of *Diplatys*, a primitive and particularly interesting Dermapteran. He remarks on how little is known about the life-history and ecology of the genus. Unfortunately this is true of almost any group one could mention, apart from a few of economic importance. Of the other eight articles in this issue four are on taxonomy, three on bionomics, one on control, and one on the coagulation of haemolymph in a cockroach.

One hopes that the editors will keep the standard of future issues high. It is a great temptation for authors to use a new publication for articles which they do not consider good enough for established journals.

R.R.

4. BUTTERFLIES OF FORMOSA IN COLOUR. By Takashi Shirozu. Pp. 481 (25.5×18 cm.). Seventy-six plates in colour. 163 distribution maps and 316 other text-figures. Osaka, 1960. Hoikusha. Price $15.

This fascinating book is the product of twenty years of study by the author, Dr. T. Shirozu. Covering as it does a large number of species which are to be found in India, the book is of great interest to biologists and collectors in this country and, inspite of the text being in Japanese, they will derive help from the book by reason of its use of scientific names printed in the Roman character, its beautiful coloured illustrations, and its numerous maps showing the distribution of the species described. The illustrations are numbered in Arabic numerals corresponding to the numbering of the accompanying descriptions. In a separate synonymic list are set out in Roman character the butterflies described in the text. There is also an index in Roman character of the generic, specific, and racial names. It is therefore very simple to find the description, illustration, and distribution map of any butterfly that the reader happens to be interested in. Reference is equally simple for the reader who makes the illustrations his basis for identifying butterflies. Some idea of the profuseness with which the book is illustrated can be gathered from the fact that there are 997 coloured pictures of the 366 butterflies dealt with. Both sexes are illustrated wherever necessary. There are, besides, numerous large-scale drawings, clear and carefully executed, of the genital organs accompanied by detailed explanations in the text ; of course, except for the specialist who already knows something of the subject, these are of use only to a reader acquainted with Japanese. The author and the publisher are to be congratulated on the superb quality of the coloured illustrations, which reproduce the natural colour and even the texture with remarkable exactness.

T. Ikawa

5. COMMON MALAYAN BUTTERFLIES. By R. Morrell. Illustrated by A. H. Burvill. Pp. 64 (21.5 × 14.5 cm.). 20 colour plates. 6 figures in black and white. London, 1960. Longmans. Malayan Nature Handbooks. Price 12*s*. 6*d*. net.

This beautifully produced handbook is designed as an introduction to Malayan butterflies for beginners and newcomers. There is no key, but almost every butterfly dealt with is illustrated and the quality of the illustrations makes detailed description unnecessary. In 58 pages of text the author has included notes on breeding habits, when known, and other points of interest for over a hundred species. Among the most interesting are the Brownies (*Miletus* spp.), colonies of which haunt particular trees and bushes for years. The caterpillars of one species are known to feed on aphids, and the author suggests that the colonies of butterflies form round colonies of aphids.

Hypolimnas bolina bolina, the Great Egg-Fly, a species common in India, is an interesting example of mimicry. The male is a striking insect, black with bold white-centred spots, while the females mimic *Danaus chrysippus*. In the nineteenth century there was a race *incommoda*, in which the females were black with sub-marginal white spots, not resembling *D. chrysippus*. By the end of the century the species became rare and finally extinct. After thirty years the species reappeared and re-established itself, but this time the females are mainly pale-brown mimics of *D. chrysippus*, although black females resembling the older form are also taken. It is noteworthy that in India the *H. bolina* female mimics *Euploea core*, the Common Indian Crow, and it is the *H. misippus* female that is a mimic of *D. chrysippus*.

Instructions to would-be collectors include advice on how to keep one's collection free from mould and insect damage, very necessary advice in a hot, humid climate.

R.R.

6. DRAGONFLIES. By Philip S. Corbet, Cynthia Longfield, and N. W. Moore. Pp. 260 (21.5 × 15 cm.). 53 colour plates, 16 photographs in black and white, 200 maps and diagrams. Key to larvae by A. E. Gardner. London, 1960. Collins. The New Naturalist. Price 42*s*.

The New Naturalist series has long since exploded two popular myths : one that the scientific expert is an erudite, inarticulate eccentric, totally incapable of conveying his enthusiasms, and the other that natural history is an inexact descriptive science. True to the tradition of the series, DRAGONFLIES is guaranteed to make an enthusiastic odonatist of any reader, and the beautiful colour plates will convince anyone, who did not know it already, that dragonflies are among the most beautiful of insects. They are also a very ancient group, with a fossil ancestry which goes back to the Carboniferous period. These early dragonflies were recognizably like their present-day descendants, but giants by comparison with them. One species, *Meganeura monyi*, had a wing span of twenty-seven inches. They must have occupied an ecological niche taken up by birds and bats today.

In the tropics dragonflies fly, and breed, right through the year. In the temperate zones, however, winter brings the flying season to an end, and dragonflies have developed methods by which they survive winter temperatures as eggs or larvae, and emerge as adults only when more favourable conditions return. Dragonfly life-histories in the temperate zones fall into three categories, each employing a different type of seasonal regulation. In the first group, the 'univoltine summer species', the eggs are the resistant, diapause, or resting stage. The larvae, which are susceptible to low temperatures, only hatch in spring, complete their development in two to five months, and emerge as adults in summer. They lay diapause eggs before winter, thus completing the cycle. The second group, ' semivoltine summer species ', overwinter as larvae. Development continues during winter, but full-grown larvae cannot emerge as adults until the temperature rises above a threshold value. This results in the accumulation of full-grown larvae during winter, which emerge as adults as soon as summer temperatures reach the required level. The third and most specialised group are the 'spring species'. Here the fully grown larva undergoes diapause, and as soon as spring temperatures become suitable there is a mass emergence of adults. These lay eggs, larvae from which will survive the next winter. However, larvae which develop more quickly than their fellows and complete their growth before the beginning of June emerge immediately, the same year as they were hatched. Whether a larva will emerge at once, or go into diapause and emerge next spring, is determined in a very precise way. Larvae respond to critical differences in day length, and after the beginning of June, when the daily increase in day length falls below two minutes, they react by going into diapause. Dr. Corbet suggests that the type of life-cycle found in the tropics is the primitive one, and those in the temperate zones represent successively more efficient ways of colonising colder latitudes. This opens up fascinating fields for speculation. Other insects in the temperate zones show life-cycles superficially similar to that of some dragonflies, for example the biting midge *Culicoides impunctatus*. An emergence peak in early summer is followed by another a little later on. Will further investigation reveal similar mechanisms in other groups besides dragonflies ?

A mass emergence of dragonflies must be impressive. It usually takes place at night. Overcrowding causes heavy mortality, for larvae crawl on top of each other, preventing those underneath from emerging. Birds kill off many of the newly emerged adults in the morning. The remainder make their maiden flight at dawn and, for the first few days of adult life, fly away from water. This response ensures that dispersal takes place. This is important because dragonflies, like birds, show territorial behaviour. Dr. N. W. Moore describes an experiment in which he released dragonflies at intervals over an artificial pond, and returned to count numbers. The number remained more or less constant over the water, the newcomers apparently being driven away.

One cannot end a review of this book without mentioning the excellent appendixes, of which the editors are justly proud. They cover every kind of information the new odonatist could possibly need, including a note to the effect that radioactive tracers *cannot* be used to tag dragonfly larvae since they are cannibalistic. R.R.

7. COMPARATIVE BREEDING BEHAVIOUR OF FOUR SPECIES OF NORTH AMERICAN HERONS. By Andrew J. Meyerriecks. Pp. 158. 15 plates and many figures. Cambridge, Massachusetts, 1960. Nuttal Ornithological Club.

In the last decade the ornithologist has been treated to a spectacular increase in the literature of his science particularly that concerned with bird behaviour. This is largely the harvest of seeds sown well before the last war by Konrad Lorenz in Germany and developed by Nikko Tinbergen, at first in Holland and later in Oxford. Comparative studies have had a leading role to play and recently a spate of works on many families, Gulls, Finches, Estrildines, and Weavers have been appearing, mostly in the periodical literature. To the European 'ethologists' it is thus gratifying to find that their observational approaches have now crossed the Atlantic and are bearing fruit in the U.S.A.

Dr. Meyerriecks's study is the second of a series of publications sponsored by the Nuttal Ornithological Club, of which Professor Ernst Mayr is the President. The intention of the series is to get into print important studies considered too large for the periodicals and not yet suitable for publication as books. One of the problems of behaviour work is the great detail of description required and this is always bulky when it comes to presentation. The club is thus performing an invaluable service to all behaviour students wishing to keep abreast of new knowledge in a rapidly expanding field.

The work consists of a detailed description of the behaviour of the Green Heron, *Butorides virescens.* Maintenance activities, locomotion, feeding, care of the body surface, escape responses, migration, agonistic and courtship behaviour are all treated in turn and the data compared with three other species, *Ardea herodias*, *Dichromanassa rufescens*, and *Leucophoyx thula*, which however have not been studied in such detail. The writing is fluid, eminently readable, and excellent photographs and figures assist the reader. The use of complex 'ethograms' for the presentation of raw data is however a pity. The number of repeat observations is too small, sometimes only a single behaviour sequence being represented, to merit illustration in large schemata. The 'ethograms' given would be better compressed into a line of text. Schemata of this, and indeed any, type are only justified if they represent a useful generalisation from a mass of observational data which is helpful to the reader. The provision of summaries would also be a help, for in such works the reader wishes to skim to certain points of interest and then refer to the necessary detail, rather than wade in detail to find the interesting points.

In the final discussion one misses consideration of the survival value of the different behaviour patterns described and their functional role in species ecology. One would like to know for example what differences in feeding niches go with the exceptionally interesting variety of feeding patterns, especially those shown by *rufescens*. The family is said to be particularly interesting on account of the differing degrees of sociality, from solitary feeding and breeding to gregarious colonial life, shown by the different species, but little attention is given to the actual spatial organisation of the populations in the environment and their relations to the exploitation of food. Nor is the degree and type of protection from predators afforded by the colony sites discussed. Adaptations in these respects may well play a major role in influencing other behaviour patterns, such as those occurring in displays.

This is however to expect too much perhaps. Excited by Dr. Meyerriecks's excellent data and capacity to interest, the reader inevitably starts asking questions that evidently lie beyond the scope of the present descriptive account. The excellent production, hard covers and cloth, perhaps lulls one into thinking one has a book in one's hands when the work is in fact a large paper. We must trust that Dr. Meyerriecks will be able to extend his work to other heron species and produce for us a monograph on the behaviour of these interesting birds.

J.H.C.

8. THE LONELY TIGER. By Hugh Allen. Pp. 191 (21.5× 14 cm.). London, 1960. Faber and Faber. Price 18*s*. net.

An interesting preface tells how the author and his sister, torn from their moorings by the war, decided to settle in India. Drawn to the forests of Madhya Pradesh, where he had hunted in his spells of war-time leave, he bought a large estate in one of the wildest parts of the Province. Largely owing to marauding wild animals, the agricultural venture did not meet with the expected success, but it raised, instead, a successful crop of shikar stories. Many of them have already appeared in well-known magazines, both in Britain and in the United States, and with adaptations have been included in this book. There are fourteen short self-contained stories but, as all the episodes recounted take place within a few miles of the author's adopted home, the book acquires a sort of unity and, half-way through, the reader gains the familiarity with the country and terrain so essential for even a vicarious enjoyment of shikar.

The reader who loves an engrossing tale will be fascinated and thrilled by the stories and, once started, will find it difficult to lay the book down. A hardened minority, however, who have some experience of the Indian jungle, may be nagged by a small questioning voice asking : 'Are the stories probable ?'. The usual shikar-story theme—going after the animal and outwitting it or being outwitted oneself—is, in this book, invariably enlivened and enriched by a variety of subsidiary incidents. Thus, a Russell's Viper intrudes upon the privacy of a melée between the author and a wild boar in its death throes. Again, just as a hungry impatient tiger is approaching the kill, with a ' growling grunt of pleasure', ' a high pitched shriek suddenly screams out of the night ' to thicken the plot and the reader's blood. The probability of fish and wild life stories will always be open to question and, the better the story, the louder the questioning voice. However, I recommend the book even to the questioning sort of reader, for it is exceptionally well written.

The author knows the jungle and its animals. What is better, he feels the jungle and its ways, and has the rare capacity of conveying his sensations to his reader—the feel of being alone in the dark, the mounting tension of stalking or waiting for a dangerous animal, the sudden fear and the slow fatigue. A natural talent for telling a story appears to have been improved and polished till considerable literary ability is evident in the outstandingly good ones. Flexibility in style and the use of words to match the mood and action bring the stories to life. For instance, consider this lyric passage : ' The black clouds were now scudding away in the wake of the grumbling storm. As they went they unveiled a star-studded sky, set with a silver moon.' Contrast it with this savage description : ' ....the first bullet slams him to the grass with his legs kicking in the air. A moment later he is a snarling blur of threshing yellow fury as he tries to rise.'

Some of the stories read in isolation may give the impression that all is well with India's wild life, especially in isolated places like the author's adopted home, Mandikhera. This impression is most effectively corrected by the story, ' The Lonely Tiger ', which gives the book its title. It vividly tells the sad tale of our beautiful fauna being wiped out from even the best of our jungles. Indiscriminately licensed muzzle loaders, booming through summer nights maim and murder every animal that comes to water. The revolting jeep-shikari blazes buckshot at every eye that shines in his blinding headlights. And above all, the apathy of the administration to enforce the law has brought desolation to India's forests. Better than volumes of official reports this story reveals the bitter tragedy of our age-old faunal heritage, which is a trust for the future, being squandered with the reckless haste of a criminal bankrupt.

Finally, I am prompted to comment on Indian shikar literature in general. Post-war books on the subject have produced a spate of dangerous tigers and panthers, mostly man-eaters ; and this, during a period that has seen a catastrophic decline in the numbers of our wild animals. The reading public's appetite for man-eaters seems to grow by what it feeds upon, and I feel sure that the author's outstanding literary ability will induce his publishers to ask for more man-eaters. Unfortunately, a time is fast approaching when any sort of shootable animal will be difficult to come across in this country. I humbly suggest that the only way open for a writer on wild life to utilize his talent is to frankly write his book in the form of a shikar romance and cast his story in the happier days of long ago.

D. J. P.

Miscellaneous Notes

1. JUNGLE DOGS KILL SAMBAR DOE

At 8.15 one morning, when I was fishing on the Badra River in Mysore State accompanied by a moplah acting as 'gillie', we saw at about 200 yards downstream a full-grown sambar doe drinking on the opposite bank of the river. After drinking a short while she retreated out of view into the jungle. A quarter of an hour later our attention was attracted by a commotion from that direction. My first impression was that a tigress with cubs was running along the far bed of the river half hidden by grass etc., but I soon saw it was the sambar doe with jungle dogs chasing her and making that queer hysterical yapping-cackling noise they make when close to their quarry. Almost at once she turned into the water and made slowly downstream at a halting walk for some 50 yards and about 15 yards from the bank. When she was about chest deep in the water, which was flowing at a moderate pace, one dog got in front of her and another on top of a rock between her and the bank as if to see that she did not make for land. The sambar then made what I like to think was a 'bell' of defiance and, whilst she was stationary, the dog in the water made a frontal attack. I was too far off to see what occurred in detail, but I saw the sambar's head and the dog disappear completely underwater. When her head reappeared she put it right up and gave a bellow of pain. After a short interval the dog, still in front, came in to the attack and again her head and the dog disappeared underwater and, when her head came out, the bellow of pain was repeated. The sambar then turned towards the bank and, after a slow halting step or two, bumped into a rock which was plainly visible. From this I conjecture that the dog had punctured her eyes and blinded her. I realised that the end was near, so started to walk down to get opposite the tragedy. By the time I arrived, she was dead and two dogs were attempting to drag her out of the water. As the bank was about a foot above the level of the water, they were unable to do so and only her head was out of the water on dry ground. I then left to do more fishing. On my return, I could see that the dogs, now gone, had only been able to clean up the head, which showed a white skull and nothing more. I am not sure how many dogs there were, but certainly not more than three (one of them lame), and definitely only one tackled her in the water.

The river was too deep for us to cross over and drive the dogs off, and our yells and abuse shouted in our best Kannada (Kanarese) were of no avail! Eventually, some locals were informed and took the carcass.

The reason I mistook the sambar for a tigress in the first instance was because she was running very low in a crouched position, either because she was blown or because a dog that I could not see was hanging on to her.

HOSKHAN ESTATE,
MALANDUR P.O.,
CHIKMAGALUR DISTRICT,
September 30, 1960.

G. V. R. FREND

2. HOW MANY YOUNG DOES A CHITAL HAVE?

In THE BOOK OF INDIAN ANIMALS the late Mr. Prater wrote: 'chital are prolific breeders; one to three fawns are born at a time—two being the commoner number'. This statement was tested on a reference by Dr. William Graf, Professor of Zoology, San Jose State College, San Jose, California, U.S.A., whose experience with chital in Hawaii is that there is no record of twin fawns, either in captivity or observed in the wild, and the examination of many pregnant does has not yielded a multiple foetus. The standard writers, like Jerdon, Sterndale, and Blanford, do not make specific mention of the number of young. Enquiries from persons likely to know have given the following results:

1. R. S. Dharmakumarsinhji of Bhavnagar, who has experience of chital in semi-domesticated conditions, has not seen more than one fawn at a time.

2. The Wild Life Club, Forest Research Institute and Colleges, New Forest, Dehra Dun, started a deer park in May 1958 with four chital. Since then 7 fawns have been born. There has been no case of more than one fawn at a time.

3. Mr. Krishna Talcherkar remembers seeing one foetus in a doe shot in Indore State.

4. The Municipal Gardens in Bombay have had several births in their garden every year. An examination of their records for 30 years (which include 97 since 1946) reveals no instance of more than one young at a time.

5. Mr. Hugh Allen of Mendikhera Estate, P. O. Matkuli, Piparia (Madhya Pradesh) reports that within the last ten years 21 wounded hinds, which had wandered into the estate and had to be shot, were pregnant; of them none had more than one foetus. Also, neither he nor Col. S. A. H. Granville of Pachmarhi, in their considerable experience, has ever observed more than one fawn with a hind.

Mr. Prater's statement is probably based on the authority of Dunbar Brander who wrote in THE WILD ANIMALS OF CENTRAL INDIA: 'one to three are born at a time, but two is the commoner number'.

In the light of these facts, it may be necessary to make an amendment in THE BOOK OF INDIAN ANIMALS.

91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
November 7, 1960.

3. INDIAN WILD BOAR (*SUS SCROFA CRISTATUS* WAGNER) FEEDING ON *BOERHAVIA DIFFUSA* LINN.

During the monsoon rains a prolific weed grows rampant in open country and scrub in the Saurashtra peninsula and in other parts of western India including the Deccan. This weed was kindly identified as *Boerhavia diffusa* by Shri K. Satyanarayana, M.SC., of the Samaldas College, Bhavnagar.

While observing the feeding habits of wild boar over many years, I have noticed them rooting at particular spots and after a brief effort eat something and move on, and then again stop to do the same. In this way open grass plots in stony ground would be neatly ploughed in bits. Subsequent examination of such plots revealed that the wild boar had removed the damp soil to the depth of 4″ to 6″ at the base of the plant and with the aid of its snout removed the earth and laid bare the tap root which in most cases had been completely eaten. At every rooting, it was this plant that had been attacked and no other; and the stem, leaves, and flowers were left untouched on the surface. The preference of the wild boar for the succulent roots of *Boerhavia diffusa* was very noticeable in open stony ground covered with soil and grass of the 'moram' type. This selective feeding of wild boar was seen at various places as far as 100 miles (*c.* 160 km.) apart. The vernacular names of the plant are Ghetuli, Punarnava, Sant, Sathodi, Thikri, and Vakhakhaparo. In English, it is known as Hog Weed, Pig Weed, and Spreading Hog Weed. It is of much interest to find that the name corresponds with the feeding habit of the wild boar, but it is unlikely that the weed is named on account of the wild pig feeding on it. The weed often grows in abundance and close together on the surface as it spreads, though the roots are fairly far apart. The wild boar do not exterminate the plant but often return to the same ground for feeding on it. Is it possible that wild boar feed on the root for a specific urge or for taste or as a natural food?

Boerhavia diffusa appears to be a useful medicinal plant and both the herb and the roots are made use of for different ailments. In what way the root benefits the wild boar is not known, but as a medicine to man, the herb has a wide use, e.g. infusion, diuretic, laxative, stomachic diaphoretic, anthelmintic, and for diseases such as Bright's disease, dropsy, œdema, anæmia, jaundice, cough, pleurisy, asthma, gonorrhoea, and for inflammation of the spleen, liver, heart, eye, and for ulcers. A poultice is also used for extracting guinea worm. It is also said to be effective for snake bite. The white flower form of this species is also found and is the more valuable for medicinal purposes.

DIL BAHAR,
BHAVNAGAR, R. S. DHARMAKUMARSINHJI
August 15, 1960.

4. FURTHER WILD LIFE NOTES FROM MADHYA PRADESH—A REJOINDER

In the August 1959 number Mr. Humayun Abdulali contributed a miscellaneous note about methods of shooting and conservation of wild life in Madhya Pradesh (*J. Bombay nat. Hist. Soc.* **56**: 321-323). Mr. Vidya Charan Shukla, M.P., in a letter to the Society, raised strong objections to certain statements therein and some correspondence was exchanged with Mr. Abdulali thereafter. Mr. Shukla wrote to the Editors requesting that his letter be published and it was thought that certain points from Mr. Abdulali's replies should also be reproduced. As, however, personal elements had crept into the correspondence, the Editors decided to publish a comprehensive editorial note embodying as objectively as possible both points of view. Pending publication, however, Mr. Abdulali is now a Joint Editor of the Journal, and the Editors considered that in fairness to Mr. Shukla his objections should be reproduced in his own words without any comments thereon omitting only passages in the nature of personal criticism. Mr. Shukla writes:

'In miscellaneous note No. 6 of Vol. **56**, No. 2 of the *Journal*, Shri Humayun Abdulali has made certain statements which are grossly misleading and erroneous. As a person closely connected with hunting and matters pertaining to wild life, I consider it my duty to correct such untrue reports.

'I am the "Managing Director of one of the leading shikar agencies in the country" who drove Shri Abdulali to Supkhar in Balaghat district to join the party of Americans who had invited him.

'We discussed wild-life and hunting, it being the topic of our mutual interest, and naturally came to the subject of illicit shooting. Shri Abdulali complained of shooting at night from jeeps with particular reference to our staff. I explained him that when a tiger or a panther is wily and the hunters fail to shoot it in a sit-up or beat and happen across it on a night-drive, when out looking for vermin, shooting of which is allowed at nights from jeep, they step down with a spot-light from the jeep, to hunt it and the jeep is driven away.

'There was no mention of spot-lights being connected to the battery of the jeep and the connecting wire being rolled all along the road or the jeep being backed the prescribed distance of 100 yards in the dark. The spot-lights used at such times have self-contained batteries and the jeep is reversed or turned according to the space available.

'The entire purpose behind restricting shooting at night from jeeps is to give a sporting chance to the animals and the method used by our hunters on such occasions affords more chances and advantages to the animals than they get in beats or sit-ups which are universally accepted methods of sport.

'From the way, the shooting of bear and wild boar at night has been described in the note, it will lead one to think that it was illegal. Both these animals are classed as 'vermin' and their shooting is permitted at night from jeeps. Apart from the legal aspects of the night shooting of these animals, their shooting whenever one gets a chance is morally just and warranted. In the forests, 95% of mauling instances are by bears who without any provocation attack the villagers when they go to jungles to seek their livelihood. Wild pig is the greatest destroyer of crops. If the wild-life preservation is considered rationally on the basis of practical experiences and circumstances as they exist, the number of such vermins will never be allowed to grow uncontrolled under the protection of game laws to the extent of being detrimental to "man and food".

'Another thing Shri Abdulali has put in my mouth during my conversation with him. From the way he has reported, it implies that we had been breaking laws in the past. What I told him was that in the earlier years of our business, our hunters did unwittingly shoot a few animals in violation of game laws; but the redeeming factor was that the matter was immediately brought to the notice of the forest authorities and due punishment was met for the same. I had taken the trouble to impress that such instances were due to inexperience of our staff and now we have gained more experience, the cases of game law violation are rare.

'The note poses a question whether it is a wise policy to "sell" the remains of our wild-life in the temptation of earning a few more dollars. A critical study of the problem of wild-life preservation at first hand will show that the real menace to our wild-life is from poaching by our own people over which neither any control is being exercised nor is being desired; and not from hunting by foreigners who without exception shoot only on valid permits and strictly restricted number of animals allowed to them. A complete watch on their shooting is always kept.

'The wild-life preservation will never assume the importance it deserves unless it shows immediate economic benefits and shikar-tourism from abroad gives a certain economic value to our well-stocked forests. Mr. Abdulali himself admits the well-stocking of our forests when he says that the party, whose guest he was, shot its quota in 10 days; but did they in any way exceed the game limit allowed to them? How are they or other foreign hunters guilty of destroying wild-life if they shoot within the limits allowed to them which is set by the Forest Department after a survey of the wild-life population? No country in the world has stopped sport-hunting to protect its common run of wild-life for the obvious reason that essentially the hunters who particularly understand the wild-life preservation problem have its interest in their hearts.'

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
November 1, 1960.

EDITORS

5. COLOUR ABERRATION IN THE WHITECHEEKED BULBUL [*PYCNONOTUS LEUCOGENYS LEUCOTIS* (GOULD)]

During the field work in the Bombay Natural History Society's Bird Migration Study Project on Kuar Bet (Great Rann of Kutch) in March 1960, two aberrant examples of the Whitecheeked Bulbul (*Pycnonotus leucogenys leucotis*) were taken in the nets. Both were young females. The over-all effect of their plumage is a uniform pale sandy, or isabelline. They differ from normal birds—abundant on the island—chiefly in the following particulars: Forehead, crown, nape, and hindneck sandy brown, concolorous with the back; in one the feathers of the crown are edged darker. Chin and throat like head. Ear-coverts silky off-white. Underparts from lower throat to vent paler sandy brown than back. Tail somewhat darker than back, all feathers tipped with whitish and largely cross-rayed.

The skins were sent to Prof. Erwin Stresemann, Berlin, for opinion. He writes:

'Your two curious skins have just arrived. I consider them to be a "pallelogical" aberration of *Pycnonotus l. leucotis*. Both are still in juvenile plumage. They are deficient in black melanins (the so-called "eumelanin") while the brownish melanins ("phaeomelanin") seem rather unchanged, which is also true for the carotenoid colouring of the under tail-coverts. The barring (cross bars) developed not only on the tail feathers but also faintly to be seen on the primaries, may (or may not) indicate that these two specimens suffered periodic starvation in the nestling stage. I know of similar cases in *Acrocephalus, Sylvia,* etc. In former days one would have been glad to make these birds types of a brand new species. But, unfortunately, they do *not* deserve such an honour! Nevertheless, they are of considerable interest.'

The arid, semi-desert area of Kutch in western India seems to favour the development of this kind of heterochrosis which Prof. Stresemann calls pallelogical, as well as albinism—total or partial. Instances have been frequently recorded in back numbers of the *Journal*, involving not only birds but also insects and mammals. The aberrant bird species recorded include Bush Quail (*Perdicula asiatica* or *P. argoondah ?*), Common Babbler (*Turdoides caudatus*), Redvented Bulbul (*Pycnonotus cafer*), Comb Duck (*Sarkidiornis melanotos*), and Great Indian Bustard (*Choriotis nigriceps*).

33, Pali Hill,
Bandra, Bombay 50,
October 29, 1960.

SÁLIM ALI

6. WHERE DO LEAF WARBLERS (*PHYLLOSCOPI*) SLEEP?

I noticed the other day how the *Phylloscopi* spent their nights when wintering in these parts. They seem to roost singly under the fronds of papaya trees (*Carica papaya*) for preference. I had observed one bird regularly settling for the night in this manner some years ago at Trivandrum. Now I have noticed the same thing happening here also. There is a papaya tree near my gate which one *Phylloscopus* (with a yellow supercilium and yellowish wing band, and calling *tsit-chew*) is visiting every evening to roost in. I believe it must be the same bird as it comes every evening just before sundown and makes its bed under the same leaf.

State Museum and Zoo,
Trichur, N. G. PILLAI
Kerala,
December 23, 1959.

[The *Phylloscopus* above could be either the Greenish Leaf Warbler (*P. trochiloides nitidus*) or the Largebilled (*P. magnirostris*), both of which broadly answer to the description. The former is the commoner of the two in the low country of Kerala.—Eds.]

7. A NEW RACE OF FINN'S BAYA, *PLOCEUS MEGARHYNCHUS* HUME

In 1954 (*J. Bombay nat. Hist. Soc.* **52** : 599-601) I compared a series of Finn's Bayas (*Ploceus megarhynchus* Hume, 1869) obtained in captivity and said to be from the Himalayan foothills in Kumaon in western Uttar Pradesh, with specimens collected in a wild state in the Bhutan Duars and in Assam. Though the differences appeared to be of subspecific value, I did not name them, as one group consisted entirely of cage birds whose origin could not be determined with certainty.

Last year Drs. Sálim Ali and J. H. Crook revisited the Rampur and Haldwani districts of Kumaon (U.P.) and discovered large numbers of *Ploceus megarhynchus* breeding in that area (*J. Bombay nat. Hist. Soc.* **56** : 457-483). The specimens which they brought back agreed with the cage birds, and a comparison with six more specimens collected by Koelz from Agia near Goalpara in Assam (very kindly lent by the Museum of Zoology, University of Michigan) prompts me to reiterate the differences between the typical form of the west and those obtained in the east:

WESTERN MALES COLLECTED BETWEEN 9TH MAY AND 20TH AUGUST (9 SPECIMENS)	EASTERN MALES COLLECTED BETWEEN 2ND MAY AND 8TH JUNE (6 SPECIMENS)
(*a*) The yellow forehead extends over 26-29 mm., averaging 27 mm.	(*a*) The yellow forehead extends over 18-26 mm., averaging 20 mm., in length,
This difference may have been accentuated to some extent by the method of preparation involving stretching or telescoping of the skin.	
(*b*) The yellow on the head is richer than that on the breast and matches that of *Ploceus philippinus*. Two first year birds (?) have their heads brownish and washed with yellow as in females.	(*b*) The colour of the head is a purer yellow.
(*c*) All have bright yellow or traces of yellow on the rump to a varying extent. Some have exceptionally large patches extending from the lower back to the tips of the upper tail-coverts. In one wild bird there is a suggestion of this being continuous with the yellow of the head (BNHS 20172).	(*c*) One (with testes 10 mm.) has the upper tail-coverts yellow (Michigan Museum 147925 dated 8th June), but others including specimens marked 'Nesting' (2nd May) show very slight or no trace of yellow.
(*d*) The yellow on the under-parts extends from the chin to the vent and includes the thighs and the under tail-coverts. This is noticeable in the colour plate accompanying Finn's description of *P. rutledgii*, *Ibis*, 1903, p. 32. None in breeding plumage shows any white on the belly.	(*d*) In none does the yellow extend to the under tail-coverts, which are white. and in four the lower belly is also white.

WESTERN FEMALES COLLECTED ON 15TH JANUARY, 10TH JULY, 6TH AND 8TH AUGUST, 12TH SEPTEMBER AND 8TH OCTOBER (6 SPECIMENS)	EASTERN FEMALES COLLECTED ON 25TH MAY (2 SPECIMENS)
(*a*) All are yellow from chin to under tail-coverts though paler than in the male and of varying intensity.	(*a*) In the two females collected by O'Donel on the 25th May in one the yellow is restricted to the chin and upper breast, while in the other it goes down to the abdomen, but does not extend to the lower belly and the under tail-coverts. This was the bird available to Whistler and termed a 'particularly vigorous female of *Ploceus burmanicus*.

These differences, which in general were accepted by Drs. Sálim Ali and B. Biswas who have examined the material, are, I think, sufficient to warrant a separation, and I hereby name the BNHS specimen No. 6933 (male) collected by O'Donel in the Bhutan Duars on 25th May 1912 as the type of

Ploceus megarhynchus sálimalii subsp. nov.

in recognition of the interest Dr. Sálim Ali has always shown in this elusive species, which interest really induced me to examine the cage birds and enquire into their plumages.

Drs. Sálim Ali and J. H. Crook have drawn attention to the extraordinary nesting habits of the western subspecies, namely that it builds nests high up in trees with entrances at the side rather than hanging nests as do the other weaver birds in India. Stuart Baker in NIDIFICATION **3** : 4 says that O'Donel in his letters to him stated that he 'had discovered the colony in a vast area of grass more or less intermixed with scrub and the nests were untidy balls of grass strips far more like the nests of *Ploceus manyar* than those of *philippinus*, and that none of them had tubular entrances. The nests were larger than those of *manyar* and were fixed to the stems of the grass, generally several of these, loosely and carelessly put together with no lining. The colony consisted of at least 20 birds but seems to have been rather scattered.'

Several of the specimens collected by Koelz are marked 'Nesting' but it has not been possible to ascertain if the nests were in grass or in trees. O'Donel's note however seems to be fairly specific that the nests were attached to grass, and though there is no evidence that O'Donel found either eggs or young in the nests, he appears to have examined completed nests. Considering that the type referred to above is in what appears to be full breeding plumage, it is unlikely that he was referring to the doodling nests in grass mentioned by Drs. Sálim Ali and Crook. Also, having once found such nests he could hardly have overlooked the very conspicuous clusters in the trees. If this difference in nesting habits is confirmed it would be an exceedingly interesting variation in habits between geographical races.

Another interesting point which requires clarification is the significance of the prominent brown collar across the upper breast, completely visible only in one cage bird dated 20th August but traces of which are visible in all the males in yellow—apparently it disappears in off plumage. Dr. Sálim Ali failed to see any individuals with such complete collars and the data available suggest that this occurs either sporadically in a few individuals or is acquired after breeding. Traces of these spots and bands are visible in females of both groups.

The eastern male dated 31st March has a tiny patch of yellow on the forehead and another on the chin. The label is marked 'Testes 5 mm.'. A female dated 30th March is very similar, except that it has no yellow other than a very faint suggestion on the chin. These two are otherwise in off plumage, with no yellow, and very similar to each other.

Dr. Sálim Ali was informed that this species bred twice a year, in July and again in September.

Much work still remains to be done on the races of this very interesting species.

Bombay Natural History Society,
91, Walkeshwar Road, HUMAYUN ABDULALI
Bombay 6,
October 27, 1960.

8. THE BLACKBACKED WOODPECKER, *CHRYSOCOLAPTES FESTIVUS* (BODDAERT), IN GANJAM, ORISSA

During the summer of 1947, a pair of Blackbacked Woodpeckers [*Chrysocolaptes festivus* (Boddaert)] aroused interest by their continual loud rattling laugh as they chased each other up the boles of tall trees standing on a flat streamside plain in dense moist deciduous forest in Coupe No. 1 Baliguda Reserve Forest, nearest village Durgapunga, 18 miles from Muniguda railway station on the Raipur-Vaisakhapatanam line. A search finally discovered their nest, situated 30 feet (*c.* 9 m.) above the ground in the trunk of a semi-decayed *Shorea robusta*, marked for felling, growing in shady forest of the same species of tree along the banks of a small stream. The young were allowed to fly—only two young emerged—before we felled the tree.

Gudur (Nellore),
S. India, K. M. KIRKPATRICK
October 31, 1960.

[The few nesting records from Kanara (Davidson), Nilgiris (Howard Campbell), and Travancore (Stewart) refer to one egg only, though in Ceylon (subsp. *tantus* Ripley) Wait says they lay one to three eggs.—Eds.]

9. THE IMPERIAL GREEN PIGEON, *MUSCADIVORA AENEA* (LINNAEUS), ON SALT-LICKS IN ORISSA

The forest country between Durgapunga in Baliguda, Ganjam, and Panjama, in northern Jeypore Samasthanam, Orissa, is a poor stag-headed Moist Deciduous Champion type 3/B, growing over a whitish chalky soil. Streams in the area carrying this mineral suspended in their waters are slightly saline; too much drinking direct from such streams causes the bowels to purge, and constant drinking results in fissure-tongue. However, animals visit stream banks to lick this mineral deposit and, watching over such licks, I have noticed that the Imperial Green Pigeon [*Muscadivora aenea* (Linnaeus)] is a constant visitor, flying down to the ground to pick the crumbs of soil thrown up by the scrapings of larger deer and Gaur. The only other Columbidae noticed on such licks is *Chalcophaps indica*, the Emeraldwinged Dove, though in this latter case I cannot say whether the birds were picking at the mineral or at the animal droppings scattered about for seeds and termites.

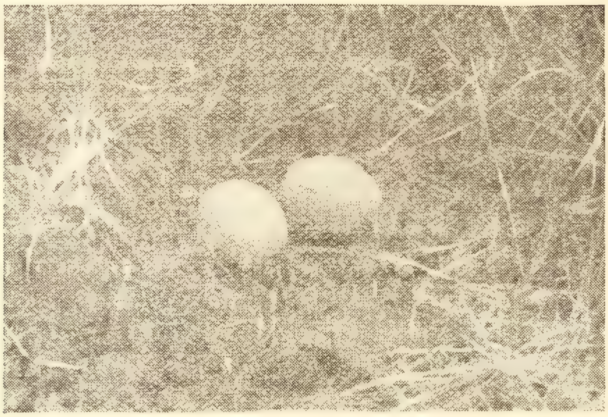
GUDUR (NELLORE),
S. INDIA, K. M. KIRKPATRICK
October 31, 1960.

10. ON THE EGGS OF THE GREAT INDIAN BUSTARD [*CHORIOTIS NIGRICEPS* (VIGORS)]

(*With a photograph*)

It has been repeatedly stated that the Great Indian Bustard [*Choriotis nigriceps* (Vigors)] lays only one egg. The largest collection of the eggs of this bustard was made by Khan Nizam-oo-din Khan; according to Stuart Baker, it was 'really wonderful' and contained many types. The next ornithologist who collected a large number of the eggs was Harrington Bulkley. Both these expert collectors strongly emphasize that the species lays only one egg. 'Harrington Bulkley once found two eggs actually together, within a few inches, but even these he believes to have been laid by two birds' (Baker, E. C. Stuart, 1935: 332). Earlier on the same page Stuart Baker writes: 'Only one egg is laid, and when two are found close together they are almost certainly the produce of two birds. Once the Khan found two eggs together but one was on one side of a tuft of lemon-grass and the second on the other side, while in two other cases two eggs were found just a yard or so apart.' Again, in 1921 in GAME BIRDS OF INDIA, BURMA, AND CEYLON **2** : 170, Stuart Baker writes: 'Khan Nizam-ud-din has taken more than a hundred of these eggs with his own hand, and he never found two eggs side by side. Where, as not unfrequently happens, two are within a yard or two of each other, he believes that they belong to different birds, and that this is a fact he has in one or two cases proved by snaring both females.'

In my long experience with bustards, which, as regards seeing the eggs, is not, however, anywhere near that of former collectors, I had never, until recently, found a nest with two eggs. Hence there seems to be no doubt that, ordinarily, one egg is laid and, when two eggs are found near each other, they are probably eggs laid by two separate hens.



Two eggs of Great Indian Bustard

And yet, it is not right to be dogmatic on this point. Stuart Baker (1921) writes on page 172: 'undoubtedly, the number normally laid is only one, and the exception to this rule is of the rarest. I have, however, in my collection one pair of eggs which are said to be from the same bird, but even here I must record the fact that they were found about a foot apart, in the same small beaten-down patch in a field of lemon grass. The eggs are of the rich brown variety, and are so exactly like one another in every detail that it seems probable that they are a pair.' No mention is given of the size of the eggs but it appears almost likely that the clutch was the outcome of a single female. The Yuvraj Saheb of Jasdan saw a nest, containing two eggs lying close to each other, and showed it to Sir Cyril Hancock, a former Resident of the Western India States, who was paying a visit to the area.

My recent experience confirms this. Last year, while closely studying the species, my shikari found a nest with two eggs (see photograph). In the grassland *vid* in which the nest was found another hen bustard was already brooding a single egg, not two hundred yards away. Subsequently, I flushed the hen off the nest in which the two eggs had been laid, and kept the bird under observation from a hide. In this case, the two eggs were next to each other, not even an inch apart and their size also indicated that they were a true pair. This is, therefore, I feel an authentic case where one hen had laid two eggs.

I took careful measurements of the pair and they were as follows: 71×53.5 mm. and 70×52 mm. It is interesting to find that one of these eggs is slightly smaller in width than the minimum width recorded, which is 53.5 mm. (Baker, 1935 : 333): In shape and colour the pair of eggs were almost alike, somewhat resembling those of the lesser florican. One egg was a pale sea-green; the other was slightly drab and had a few rusty markings. Both had very few, or hardly any, pimples.

Jerdon (1864 : 610) writes: 'The female lays one or two eggs . . .'. On what grounds he mentions two eggs is rather obscure. However, a conclusion can now be drawn that the Great Indian Bustard does lay two eggs but does so very rarely.

DIL BAHAR,
BHAVNAGAR,
August 9, 1960.

R. S. DHARMAKUMARSINHJI

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11. ASSOCIATION BETWEEN DIFFERENT SPECIES OF TURNICIDAE

On Sunday, 9 October 1960, whilst on my way to the big swamp near Chintavaram on the Gudur-Yerur Road, I stopped in scrub-jungle to catch a young *Turnix dussumieri*, the Little Button-Quail, apparently the last of its brood, that legged it off the road behind the parent to take cover in weeds beneath a thorny shrub, from where we caught it by hand. The little mite took captivity well, settling down to consume, for its ping-pong-ball-size, an enormous quantity of termite larvae.

On Tuesday, 11 October 1960, a friend sent me a basket of eight *Turnix suscitator*, the Bustard-Quail, comprising seven females and a solitary male. The male was rescued from the kitchen-knife and put into a cage next to the baby *T. dussumieri*. The baby at once began to struggle frantically to get through the wires to join the larger bird until, nervous that it might damage itself, we put it into the same cage. It ran 'peep'-ing loudly to the *T. suscitator*, who accepted it beneath its breast without demur, and the two now live together as father and adopted son quite happily, the elder bird breaking the cells of the termite houses given them and allowing the younger to come forward and feed freely. At night, the baby *T. dussumieri* nestles beneath the embracing feathers of *T. suscitator* to sleep, and at no time has the elder bird attempted to drive the baby away.

This is interesting as quails are usually nasty-tempered little birds.

The other interesting feature is the quantity of termites and termite larvae that they consume, showing a marked preference for these to seeds and other small soft-bodied insects. Surely they must constitute an important controlling factor over these damaging insects?

GUDUR (NELLORE),
S. INDIA, K. M. KIRKPATRICK
October 13, 1960.

12. MARSH SANDPIPERS (*TRINGA STAGNATALIS*) COLLIDING AGAINST TELEPHONE WIRES

On the morning of 22 December 1958, when I was driving along the new jetty road to the port of Bhavnagar, a three-mile stretch of road passing through salt pans with telephone posts and wires along the side, I saw three birds out of a large flock of Marsh Sandpipers (*Tringa stagnatalis*), which flew across in front of me, drop suddenly like stones, as if shot in the air. Amazed, I stopped, got down from the car, and went over to the side where I found the ill-fated birds, one of which was still fluttering in its death throes. One by one I picked them up, and saw that two had their necks neatly cut and were bleeding from the throat and gape, and the third had both its wings cut. Immediately, I realised the cause of the accident, the telephone wires. On the following morning, driving past the same place, I found a dozen birds, all Marsh Sandpipers, lying on the side of the road freshly killed, and a Brahminy Kite gliding over the road and picking up a dead bird. I then carefully observed the to-and-fro feeding flights of the Marsh Sandpipers which passed close past the telephone wires and watched their sudden swerving up or down to avoid them. The real fact was that a flock of *T. stagnatalis* feeding on one side of the road in shallow saline water a few inches deep, served as a decoy, thus attracting other feeding flocks of the same species to join them The in-coming flock would fly low across the road, often followed by another in quick succession, and in this process some birds collided against the wires and were killed. I have often driven along the same road and watched the feeding flights of other shore birds but have not found any dead by the roadside, although I once saw a winged flamingo and also a spoonbill.

DIL BAHAR,
BHAVANAGAR, R. S. DHARMAKUMARSINHJI
August 16, 1960.

[Telegraph wires in certain places take a heavy toll of birds, particularly those which move in flocks. At Bharatpur in Rajasthan, we were informed that during the cold weather, people patrolled the line of telegraph posts along the famous duck jheels to pick up one or more duck every day.—EDS.]

13. THE CHRISTMAS ISLAND FRIGATE-BIRD, *FREGATA ANDREWSI* MATHEWS, IN INDIAN WATERS—A CORRECTION

I recently had occasion to re-examine the frigate-bird in the Society's collection obtained by L. A. Lampard at Quilon, Kerala, and recorded as *Fregata andrewsi* Mathews in *J. Bombay nat. Hist. Soc.* (1929) **33**: 445. This was repeated by Whistler & Kinnear [*J. Bombay nat. Hist. Soc.* (1937) **39**: 450] and Sálim Ali (1953) in THE BIRDS OF TRAVANCORE AND COCHIN. The latter included therewith a young specimen obtained by Ferguson near Trivandrum and originally noted as *Fregata ariel.* The identity of the latter cannot now be checked upon, but the specimen in Bombay is completely black with the upper plumage glossed with green and the lesser wing-coverts brown. The primaries are moulting and several having dropped off, the two wings are of different sizes, the larger being only 524 mm. The tail is 410 mm., and the exposed culmen 96 mm. (gape 129 mm.), making it *Fregata minor*. This leaves no authentic record of *F. andrewsi* from Indian limits, and records from Ceylon have also been determined as in error for *F. minor* [Gibson-Hill, *Spolia Zeylanica* (1953) **27** : 95-96].

Fregata minor has been recorded independently from Bombay by Commodore R. M. T. Taylor, Mr. C. McCann, and Dr. Sálim Ali in June and early July [*J. Bombay nat. Hist. Soc.* (1953) **51** : 939], and referred to as the Lesser Frigate-bird. It may be worth mentioning that, in spite of the name *minor*, this is not the smallest frigate-bird and Alexander [THE BIRDS OF THE OCEAN (1955) p. 168], Whistler [Avifaunal Survey of Ceylon. *Spolia Zeylanica* (1944) **23** (3 & 4): 288] and Henry [GUIDE TO THE BIRDS OF CEYLON (1955): 367] all refer to it as the Great Frigate-bird, restricting the term Lesser or Small to *Fregata ariel*!

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
October 3, 1960.

HUMAYUN ABDULALI

14 OCCURRENCE OF THE LEAST FRIGATE-BIRD [*FREGATA ARIEL* (G.R. GRAY)] IN BOMBAY

In July 1960 a frigate-bird was shot with a .177 airgun by Mr. Kevin Miranda at Land's End, Bandra, near the sea-shore, and sent to St. Xavier's High School, where it is preserved. It was flying just above the water with a fish about 6 in. long in its beak. The bird is all black, the feathers of the head and upper parts have a metallic green sheen, and taper to points. The under parts are duller with two white patches on either side of the belly extending to the under wing-coverts.

The wing measures 520 mm., the tail 325 mm., and the bill from the feathers 82 mm. (96 mm. from gape).

The colour and measurements agree with those of a male Small Frigate-bird, *Fregata ariel* (G. R. Gray), and this would appear to be the first record of this species from India though it had been noted from the Maldives and Ceylon. In the *Journal* (1904) **16** : 13 Ferguson wrote of a young bird being taken at Perumathoray, about 10 miles from Trivandrum, but Sálim Ali (1953) in THE BIRDS OF TRAVANCORE AND COCHIN has referred to this as *Fregata andrewsi*. In the absence of the specimen and the fact that only two species were recognized in Ferguson's time, this record must now be written off as uncertain.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
October 3, 1960.

HUMAYUN ABDULALI

15. A NOTE ON THE COMMON MONITOR, *VARANUS MONITOR* LINN.

Several reports on monitors have been published in the *Journal of the Bombay Natural History Society.* Without making any reference to or comment upon previous records, the writer wishes to record his own observations.

Breeding season, etc. The breeding season of the Common Monitor, *Varanus monitor* Linn., in Uttar Pradesh, as observed by the writer in Lucknow and Gorakhpur, extends from the middle of April to the end of July. The number of eggs laid by the females of this species varies from 8 to 19 (as was apparent from the collection of eggs on five occasions). The size of the eggs varied from 47×36 mm. to 55×44 mm., the average size of 50 eggs being 49×38 mm. The weight of the eggs varied from 9.3 gm. to 14.5 gm., the average weight of 25 eggs, sorted at random, being 11.4 gm.

On one occasion, the eggs were collected from beneath thick vegetation in a ruined and neglected building, about five miles (8 km.) from the Lucknow University. However, this seems to be unusual because this lizard normally digs a hole in the ground, deposits its eggs in the hole, and covers the eggs with the dug-up earth and other débris in such a way that it is difficult to spot them.

All efforts to get freshly hatched young ones from the eggs under laboratory conditions, for infection experiments, proved futile.

During the course of his investigations on the incidence of opalinid (Protozoa) infections in the preserved specimens of the various species of monitors in the collections of the Zoological Survey of India, the writer came across two female gravid specimens of *Varanus monitor* which were collected from Bikaner State (Rajasthan) on the 5th April 1957. The specimen Reg. No. 20739 measured 54.1 cm. in length, and the other, Reg. No. 20740, measured 35.2 cm. (both measurements are inclusive of the tails). The former specimen was found to contain 17 eggs, the latter 9 eggs, a result which accords with the assertion of Smith (THE BRITISH AMPHIBIANS AND REPTILES, 1954, p. 169) about British lizards that the number of the eggs produced at one time increases with the age and size of the female. The eggs were more or less fully mature; thus, it seems that the breeding season of *Varanus monitor* begins in Rajasthan sometime earlier than April.

Diet, habits, etc. As regards the diet of *Varanus monitor*, all sorts of seizable prey has been included in its menu. However, the writer from his observations on this lizard in the field, and from the examination of the gut-contents of a large number of specimens [as also of the gut-contents of several specimens of *V. flavescens* (Gray), *V. griseus* (Daudin), and *V. nebulosus* (Gray)], feels convinced that these mostly terrestrial monitors feed primarily on large insects (beetles, grasshoppers, roaches, etc.), and small lizards and snakes. Birds and their eggs, small rodents, and other animals are only occasionally preyed upon. They are, no doubt, fond of rats and mice, but in view of their diurnal habits the monitors do not frequently come across these rodents, which are mostly active during the night. Further, the Common Monitor as well as the other terrestrial species mentioned above do not seem to have a liking for an amphibian diet: they probably prey upon frogs and toads in nature, as a last resort only. Vogel [REPTILE LIFE. Translated by Margot Schierl (1958): 32] has justifiably remarked that very few of the monitors will look twice at a frog. The situation in captivity is different, and an anuran diet will not be rejected.

Varanus monitor seems to be a very hardy animal in respect of withstanding starvation. During the course of his researches at the Lucknow University, the writer managed to keep some specimens of this lizard starving for over seven months in captivity.

In the plains, the Common Monitor hardly digs a burrow for itself; it mostly occupies the burrows of rodents, or hides itself in thick vegetation or neglected buildings; it takes to ponds and pools but rarely. The writer has never seen young ones of *Varanus monitor* taking to trees; adults, when cornered, readily climb up a tree; also sometimes for the sake of eggs and chicks of birds.

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March 19, 1960.

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16. OBSERVATIONS ON THE RED EARTH BOA OR RUSSELL'S EARTH-SNAKE [*ERYX CONICUS* (SCHNEIDER)]

I had opportunities to observe, in nature and in captivity, some of the habits of the Red Earth Boa, or Russell's Earth-snake [*Eryx conicus* (Schneider)], known in Malayalam as *mannuli* (burrower) with reference to its burrowing mode of life. It is also called *mannutheeni* (sand-eater) because of its reputed sand-eating habit, a belief which has no factual basis.

E. conicus spends the whole day buried in small crevices or holes in the ground. I once collected a specimen from a burrow nearly 1½ feet (45 cm.) below the surface in loose sandy soil. It is nocturnal in its habits and moves out at night in search of prey consisting of mice, field rats, toads, small lizards, and birds, which it kills by constriction. It cannot endure long periods of starvation.

The dark brown patches on the back of *E. conicus* are bordered by luminous white margins, which would obviously be more discernible to other nocturnal animals than the blotches. This probably helps it in securing its prey.

The visual power of *E. conicus* is as good as that of any other snake, and when underground and unable to see in the darkness it can perceive even the smallest sound vibrations made on the ground. It will remain buried for hours on end in captivity with only the snout and the eyes exposed, retreating into the sand and burying itself completely at the slightest disturbance. It can remain underground for nearly an hour at a stretch. Unlike the common land snakes, *E. conicus* does not protrude and retract its tongue repeatedly; it does so only when it is subjected to considerable physical irritation. This indicates that the tongue is not used much in the way of a sense organ.

E. conicus shuns bright sunlight, and recedes into the dark corner of a partially illuminated cage. I have, however, seen it occasionally basking in dim sunlight. Burrowing in sand is usually a matter of a few minutes, and in consequence *E. conicus* is more at home in sandy soil. It is nevertheless not quite rare elsewhere. While burrowing the body is thrown into lateral folds; the burrowing is initiated by the head, and is doubtless facilitated by the scooping action of the lateral folds and the slightly prehensile tail.

In captivity *E. conicus* is gentle and well-disposed, becoming active only when artificially irritated or at night or during the capture of prey. The body is ordinarily cylindrical. Under provocation it assumes the threat posture and the body becomes dilated, turgid, and plano-convex in shape; one row of outer scales on each side is pressed on the ground, distending the costals and making the lateral spots stand out more vividly. With the lateral spots completing the gaps in the picture the resemblance to the Russell's Viper [*Vipera russellii russellii* (Shaw)] becomes very strong, earning it the name of *payyanamandali* (from *payyana*, the vernacular name of a plant the leaf-scars of which bear a peculiar resemblance to the spots of *E. conicus*, and *mandali*, viper). The flattened lower surface helps it to get a better grip of the ground. One specimen, which remained with me for some time in captivity, used to press its flanks to the ground along the whole length of its body. The mechanism involved in this dilation of the body is under investigation. Another threat posture takes the form of throwing the body suddenly into coils under which it hides its head.

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17. MATING BEHAVIOUR OF THE BEETLE *HYDROPHILUS OLIVACEUS* FABRICIUS

Hydrophilus olivaceus Fabricius belongs to the family Hydrophilidae, order Coleoptera. It is found in the local ponds and comes to light in large numbers. Some of these adults were collected and put in small water tanks and their mating behaviour was studied by the author in the laboratory. One pair was isolated in a glass tank. Externally there is not much difference between male and female beetles except that the males are generally smaller than females. The male rides over the female holding the elytra at the sides by its forelegs, mid- and hind-legs free and the mouth parts rubbing the groove between prothorax and mesothorax. During mating, the female swims while the male keeps on riding over her. The union is effected by the full extension of the aedeagus by the male which touches the female genitals. The female does not protrude its genitals as in some orthopteran insects and makes no copulatory movements. The male succeeds in inserting the aedeagus in the female genitals only after many unsuccessful attempts. At the time of complete union of the two genital armatures, the female does not move but remains stationary. The full union hardly lasts even forty seconds. After mating the male comes up at the surface to take air and very soon returns to the female to mate again. A cracking sound is made by the male when he approaches the female. The sound produced is very feeble and is audible to the human ear at a distance of about one foot only. The female does not chase the male for copulation. It has been observed that the male keeps on riding over the female for hours if the female comes to the water surface quite often. At intervals the frequency of mating is once for every minute and is continued for many days even without any food.

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S. N. MATHUR

18. MIGRATIONAL FLIGHTS OF THE COMMON INDIAN CROW BUTTERFLY [*EUPLOEA CORE* (CRAMER)]

In this note I record two migrational flights of the Common Indian Crow butterfly [*Euploea core* (Cramer)] through Bombay, one in a northerly direction seen on 20 June 1960, the second in a southerly direction seen on 23 July 1960.

Since January 1960 I am observing the movements of certain species of butterflies, including *E. core*, in my garden on Pali Hill. I watch from a window on the first floor. Observations are confined to the patch of garden directly in front of the window, measuring roughly 50 ft. by 55 ft. (*c.* 15 by 16 m.). On the north the area under observation is cut off from the adjoining compound by a dense line of mango trees, a 4 ft. (*c.* 1 m.) high rubble wall, and low bushes. On the west runs a municipal road, about four feet (*c.* 1 m.) below the level of the garden. Further west, across the road, there slopes down for about 60 yards (*c.* 55 m.) a piece of waste land surrounded by mango trees with a few mango trees scattered over it, largely stripped of their leaves and smaller branches by foraging goat-herds and fuel-hunters. On the south the garden extends about 70 ft. (*c.* 21 m.) more and is separated from the garden next door by a brick wall and a line of trees of various kinds. On the east of the observation area is my house, which extends about 30 ft. (*c.* 9 m.) further south. Observation is done in watches of 15-minute duration scattered throughout the day.

From the beginning of March, the population of *E. core* was low. In fact, in April I saw only three *E. core* in 97 watches and in May none at all in 73 watches. In 25 watches from the 1st to the 19th June, I saw only one butterfly at all resembling *E. core* but could not identify it with certainty. The first sign of a change came in the morning of 20 June when I noticed one *E. core* flying slowly round in the garden settling on the flowers. Then in my 11.45 to 12.00 watch I observed two *E. core* both flying north, at a height of about 20 ft. (*c.* 6 m.) above the ground. This was followed by 19 *E. core* in the 12.05-12.20 watch, all flying north at heights varying from 15 to 30 ft. (*c.* 5 to 9 m.) above the ground. From my post of observation I could see a similar flight taking place over the waste land beyond the road. The butterflies flew steadily and slowly forward at about 6 to 7 miles (*c.* 10 to 11 km.) per hour. They seemed to take no interest in their surroundings or in each other, except for three over my garden which flew round and round each other for a little while at the same time moving forward slowly to the north. At 13.00 hours, after lunch, I went into the garden. There was no flight in progress and only one *E. core* was to be seen flying slowly from flower to flower in the garden. I went to the waste land across the road and to a more open piece of land further down, but observed no *E. core* in either place. In my next watch, from 13.40 to 13.55 hours there were 4 *E. core*, 3 flying high and steadily north like those previously observed and one flying low and moving slowly about in the garden.

At the time of these observations there was a slight breeze blowing from the west. The temperature in the shade was about 30.5° C. Rain-clouds covered the sky; the sun showed through in the first watch but was obscured throughout the other two watches. There was no rain.

On the 21st and on subsequent days I continued my watch in the garden and kept a look-out for *E. core* while moving about in Bombay. I saw a few *E. core* flitting about at a low height; there was nothing resembling a migratory flight. This position continued till the 23rd July, when there was a sudden increase in numbers. The main flight this time was from north to south, but it was not as purposeful and uniform as on the previous occasion; also, the butterflies flew more slowly, about 4 to 5 miles (*c.* 6 to 8 km.) an hour, and after coming over the line of mango trees along the northern boundary of my garden they came down lower than on the 21st June, some of them to about 10 ft. (*c.* 3 m.) height. My observations on this day can most conveniently be given in tabular form (Table I).

TABLE I

Time of observation	No. seen and direction of flight							Sun	
								showing	obscured
	S	N	SE	SW	W	E	F	min.	min.
11.40-11.55	13	—	2	—	—	—	2	6	9
12.15-12.30	3	2	—	—	1	1	3	0	15
13.45-14.00	—	1	—	1	—	—	3	15	0
14.20-14.35	3	—	—	—	—	—	2	15	0
Total ..	19	3	2	1	1	1	10	36	24

Note: In the column headed F are shown butterflies which flitted about in the garden.

It will be seen that of the butterflies observed 10 flitted about without flying in any definite direction. Of the rest 19 flew south, 3 north, 2 south-east, 1 south-west, 1 west, and 1 east. I did not notice any flight over the waste land across the road on the west. Between 12.30 and 13.45 hours I visited the open land to the east of my house; there was no flight in progress and only 2 *E. core* were to be seen, flitting about from plant to plant.

The 23rd July was a cloudy day, with no rain, still during the first three watches and a westerly breeze in the fourth watch. The sun was obscured for the greater part of the first watch and the whole of the second watch, and shone throughout the third and fourth watches. The temperature in the shade was about 32.5° C. during these four watches.

On the 24th July, 1 *E. core* was flitting about in the garden at 7.33 a.m. and in six watches later in the day only 2 *E. core* were seen, both flitting about in the garden. Heavy rain interrupted watching from the 25th to the 27th. In the rest of July and in August, the numbers of *E. core* seen were low. In September numbers increased. Table II summarises the changes in population from January to September.

It will be seen that between the two migrations observed by me, and immediately before and after them, the population of *E. core*

TABLE II

	Jan.	Feb.	Mar.	Apr.	May	June			July			Aug.	Sept.
						1-19th	*20th*	*21-30th*	*1-22nd*	*23rd*	*24-31st.*		
No. seen	4	53	10	3	0	0	25	3	4	37	6	4	33
No. of watches	61	124	114	97	73	25	3	20	22	4	21	56	48

in my area of observation was small and was not sensibly increased, and in my movements in the city of Bombay I saw very few *E. core.* So it seems likely that Bombay merely lies on the line of migration, outward and return.

Looking through old issues of the Society's journal I find that the northward migration of *E. core* has been observed several times. Aitken (1897, 1901) saw it in at least eleven separate years and reported two specific instances. The earlier report, sent from Ratnagiri, relates to a migration which began on 7 June 1897, but it is not clear at what place the migration was witnessed. The second migration was observed by him from the Esplanade in Bombay on 22 July 1900. The usual date for the northward migration is in the beginning of June according to him, but in 1900 the migration occurred later under peculiar weather conditions. His experience was that the migration continues through one day and sometimes goes on for a second day. The northward migration seen by Miss A. Ghose in Bombay on 13 June 1937 is described as having lasted for only two hours, but must have been on a vast scale as her estimate of the insects that passed through in that time was 30,000 (Williams, 1938, appendix). Of the return journey I can find only one previous report (Aitken, 1898). It was observed over Bombay in July 1898, first noticed on the 26th at 4 p.m., resumed in the early morning on the 27th, and continued till 'the afternoon at least'. The migrations seen by me were on a much smaller scale than those formerly reported, both as to duration and as to the number of insects seen. But they pose the same questions as were put by Aitken long ago: where do the butterflies come from? where do they go? Do the same insects perform the return journey or the immediately following generation as Aitken guessed? why do they migrate? and so on.

Davidson & Aitken (1890) report that in June 1889 in Karwar *E. core* was seen in great numbers which 'almost amounted to a plague', it disappeared in July, and was found again from August onwards. Apart from Aitken's report from Ratnagiri, I have ascertained from some residents of Ratnagiri that the phenomenon of migration is well known in that district. These facts suggest the possibility that Kanara and its neighbourhood are the starting place of the outward migration and the destination of the return migration, and that the route lies along or near the western sea-coast of India. Observations in this area may be fruitful of results.

Aitken (1897) mentions that the villagers connect the northern migration with the approach of the monsoon. In this connection his observation of July 1898, published under the heading 'Butterflies as weather prophets', is interesting. The weather conditions in that year were very gloomy. There was no storm in May, not even distant thunder and lightning. Apart from heavy but irregular rain for about a week, there was very little rain in June. After squally weather on the 12th June and for a few days thereafter the weather set fine and, to the despair of everybody, there appeared to be no prospect of more rain. In these circumstances, when Aitken on seeing the migration on the 22nd July told a friend: 'It is all right—the monsoon is coming in three days', he was ridiculed. But his prophecy came true. On the very next evening there was a heavy shower of rain, there were thunderstorms on the next four evenings, and the monsoon 'broke regularly' on the 28th and continued satisfactorily thereafter. Aitken's conjecture is that the butterflies fly north to escape 'the heavy rain with which the monsoon opens on the southern coast' (Aitken, 1898). Examination of the figures of rainfall in 1897 and 1937 as recorded at the Colaba observatory gives the following results. In 1897, when the migration was observed on the 7th June, the rain started on the 6th and continued steadily to the end of the month with only four days on which there was no rain. In 1937, when the migration occurred on the 13th June, rain started on the 12th June and continued to the end of the month without a break of a single day. Apparently, therefore, there is some connection between the northward migration and the onset of the monsoon. But in 1960, ignoring a few scattered showers in May and the first light rainfall in June, the monsoon began about the 13th June, that is to say about a week before the northward migration. It does not necessarily follow that the belief of the villagers is mistaken, for Bombay is merely on the route of the migration; to attempt an answer to the question we want to know the weather conditions at the start and at the turn of the migration.

The migration appears to be comparatively limited in its extent, and regular in its occurrence. The metallic gold (sometimes silver) chrysalis of the butterfly, the distinctive marking and shape of its wings, and its leisurely flight make it easy to identify and to observe. It therefore provides an excellent opportunity for probing into the motive causes of insect migration, a problem that is still imperfectly understood. The first requisite is to ascertain the starting and turning points of the seasonal movements, and the routes followed on the outward and the return journey, together with relevant details about dates and local weather conditions. Every scrap of information will help; observers willing to take part in collecting material should address their reports to the Society. Details of the points on which information is desired are set out in the Editorial Note appended to Miscellaneous Note No. 16 at page 430 of the Society's *Journal* Volume 57, No. 2.

To assist those who may desire to help in collecting material it will be useful to complete the analysis of the reports which I have found in the literature consulted.

October appears to be a month in which *E. core* may be expected to be on the move. Prall (1898) reports that on 21 October 1897 he saw a procession of *E. core* 'passing down the harbour' (? going south) at Mody Bunder in Bombay. 'Many hundreds' must have passed in the hour during which he was watching. Andrewes (1909) reports that on 18 October 1908 in Ouchterlony Valley in the Nilgiris he saw *E. core* 'by thousands' floating high over the treetops of the dense forest, all without exception going west. This went on for the four hours that he was there. Three days later, on the 21st, hardly an *Euploea* was to be seen. Wall (1921) on 28 October 1921 witnessed an eastward flight at sea during a voyage from Karachi to Bombay. The flight went on all day and was particularly thick opposite Madiapur on the Kathiawar coast, about 5 to 6 miles (*c.* 8 to 9 km.) from land. Several species were seen, and among those identified was one '*Euploea*, probably *core*'. As the nearest land to the west is some hundreds of miles distant he conjectured that the butterflies were 'blown out to sea by a strong current and driven back by a reverse current'.

Other observations are a flight to the south-east on 28 March 1909 witnessed by J. Evershed at Kodaikanal in south India

(Williams, 1938, at p. 445), and one to the east in July 1922 witnessed by Tulloch at Deolali (Williams, 1938, at p. 449). My observations showed rises in February and September, but no mass movement.

49, PALI HILL,
BANDRA, BOMBAY 50,
October 29, 1960.

D. E. REUBEN

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19. *PLUSIA* (*PHYTOMETRA*) *NI* HB. (NOCTUIDAE) AS A PEST OF CABBAGE, *BRASSICA OLERACEA*, IN SOUTH INDIA

For the past few years a green semilooper, *Plusia ni* Hb., has been found to inflict serious damage on the crop of cabbage (*Brassica oleracea*) in Madurai district. Since the insect has been noted for the first time in south India as a serious pest on cabbage, a crop which is grown on a commercial scale on the hills and in the plains, a short account of it is given in this paper.

DISTRIBUTION. Hampson (1894) has given San Domingo, Europe, St. Vincent (Cape Verde Is.), Aden, Japan, China, and north-west India as its distribution. Fletcher has stated that it occurs throughout India, but the records of its occurrence extend only to Pusa, Lahore, Surat, Kumbharia (Bombay), United Provinces, Gujarat (Fletcher, 1921), and Dehra Dun (Gardner, 1947).

It is of interest to note that Fletcher (1921) has recorded a few species of the genus *Plusia* (*Phytometra*) as occurring on cabbage in N. India; they are *Plusia ni* Hb. in Surat and Kumbharia (Bombay), *P. chalcytes* Fb. in Kumbharia (Bombay), *P. orichalcea* Fb. in Poona, Nagpur, Pusa, etc., and *P. signata* Fb. in Bihar, but he is doubtful about the correct identification of the last named species.

FOOD PLANTS. Larvae of *Plusia ni* Hb. were noted on cauliflower in Pusa and Lahore, on cabbage in Surat and Kumbharia

(Bombay), on opium poppy in United Provinces and Gujarat, and on safflower, nettle, and *Solanum* (Fletcher, 1921). In the insect collections at the Agricultural College and Research Institute, Coimbatore, it is seen that a few specimens have been collected on Sunflower (*Helianthus annuus*) at Coimbatore by R. N. Chari in 1923. Gardner (1947) has noted the larvae on *Antirrhinum*, cabbage, and tomato in Dehra Dun. The insect has now been noted to be a severe pest of cabbage in Madurai district (Madras State), and it has not been observed to feed on any other plant in this locality.

NATURE OF DAMAGE AND SEASONAL OCCURRENCE. During the last 4½ years this insect has been found to appear regularly from September to April on cabbage in Periyakulam, parts of Tirumangalam, Nilakottai, and Dindigul taluks of Madurai district, where cabbage is grown on a commercial scale in about 2000 acres (*c.* 800 hectares). The caterpillars appear both in the nursery and on the planted crop, and eat away the leaves leaving only the veins and midribs. In severe cases the crop had to be ploughed in. The damage is marked when the caterpillars attack the crop at the time of formation of heads. About 30-60% of the yield is affected.

Since the insect has assumed serious proportions in this area and the other common pests of this crop are not known to cause such severe damage it is considered to be of major economic importance for cabbage.

LIFE-HISTORY. The female moth lays greenish white, spherical, sculptured eggs singly on the undersurface of the leaves. The caterpillar is slender and attenuated anteriorly and moves as a semilooper. It feeds gregariously on the leaves and when full-grown measures about one-and-a-half inches (*c.* 38 mm.) in length and is green in colour with light wavy white lines and a broader lateral stripe. It pupates on the undersurface of the leaves in a thin transparent silken cocoon.

The moth is stout, brown in colour, with light wavy markings and with a more slender Y-mark on the forewings.

NATURAL ENEMIES. So far no parasites or predators have been noted on this insect in this locality.

CONTROL. The widespread attack by this pest made the cultivators try control with chemicals. In the early years, the cultivators either dusted with 5% DDT or sprayed with 0.25% DDT. In course of time as this did not give satisfactory results the cultivators tried spraying Endrex 20 E.C. at 1 oz. (*c.* 28 gr.) in 6¼ gallons (*c.* 28 litres) of water and parathion 0.025% [Folidol 1 oz. (*c.* 28 gr.) in 12½ gallons (*c.* 56 litres) of water]. As these chemicals control the pest and the plant lice as well, these methods are widely followed by the cultivators. They have been advised to handle the chemicals with care as they are poisonous and to stop the application a month before the harvest of the crop to eliminate residue hazards. An insecticidal trial with a view to control the pest effectively without any residual effect, as it is a vegetable crop, is worth pursuing.

ACKNOWLEDGEMENTS. My thanks are due to Dr. M. G. Ramdoss Menon, PH.D., Systematic Entomologist, New Delhi, for permitting me to study the collections at the Indian Agricultural Research Institute, New Delhi, and to the Director, Commonwealth Institute of Entomology, London, for identifying the insect. Thanks are also due to Dr. S. Kanakaraj David, PH.D., Reader in Entomology, and to Sri K. R. Nagarajan, B.SC. (Ag.), Crop & Plant Protection Officer, (Entomology), Coimbatore, for their kind help and valuable suggestions in the preparation of this note, and to Sri R. Subbiah Pillai, B.SC. (Ag.), District Agricultural Officer, Madurai, for encouragement and facilities given in making the observations.

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20. *SYNGAMIA ABRUPTALIS* WALKER (PYRALIDAE—LEPIDOPTERA): A NEW PEST OF *MENTHA VIRIDIS* L. IN SOUTH INDIA

INTRODUCTION

Mentha viridis L. (Labiatae) (Tam. *Podina*) is a small perennial herb commonly grown in kitchen gardens and used for seasoning many culinary preparations. The thick, fleshy leaves are used for making *chutneys*, for flavouring soups, salads, etc. It has a medicinal value and has been used for curing hysteria and some infantile troubles. So far no insect has been noted as doing any marked damage to the plant. Recently, however, the caterpillars of the moth *Syngamia abruptalis* Walker were observed causing the withering of the plants on a large scale in the orchard attached to the Agricultural College and Research Institute, Coimbatore. Since it is recorded here for the first time, the observations made are given below.

PREVIOUS RECORDS

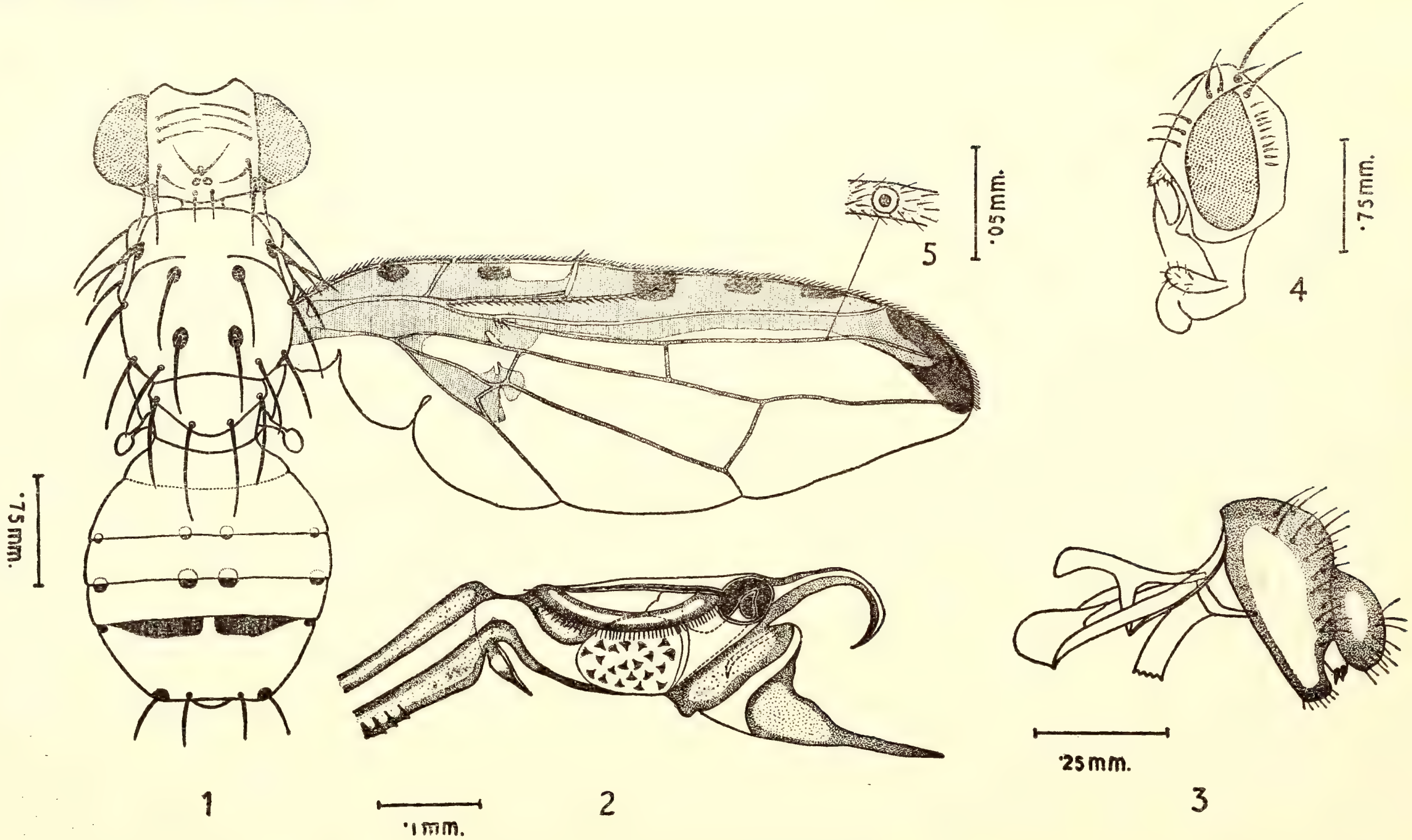
Lefroy (1909) noted the insect on *Ocimum sanctum* L. (Tam. *Thulasi*). It has, however, not appeared in any large proportions on this plant. No further information is available on this insect from India. Shroff (1919) mentioned it as 'not a serious pest' on the leaves of mint, in Burma. According to Zacker (1913) it is a leaf-feeding pest of cotton, in Africa.

CHARACTERISTICS OF THE INSECT

The caterpillar folds the leaf in a characteristic way and feeds inside. The edges of the leaf are brought together and folded along the midrib in the longitudinal axis. The edges are united by silk filaments, and the doubled leaf is seen as a flat one. Many leaves in the terminal shoot are also loosely webbed with stray strands of silk. The caterpillar rests near the midrib with its head pointing towards the stem, and scrapes the parenchyma in the inner portion of the folded leaf, leaving the lower epidermal portion intact. It attacks 2 or 3 leaves in the same branch before it attains full growth. The folded skeletonised leaves gradually wither away. Consequently, the branch where it has been feeding dies. Two or three caterpillars have been noticed on different leaves in the same branch.

The fully-grown caterpillar measures 22 mm. in length. The head capsule is light yellow to light brown in colour. The body is pale green in the young stage, but turns yellowish later. Black spots with hairs are present on the dorso-lateral aspect in the thoracic and the first 8 abdominal segments. There are also short hairs arising singly in other portions of the body. On disturbance the caterpillars move quickly in jerks and hang on silken threads. Just before pupation red patches are developed around the dark spots on the body.

Pupation takes place inside the leaf-fold in a white cocoon made of a few strands of silk. The pupa is brown, about 8.5 mm. in length, and is attached to the leaf by the anal end.


1
·75mm.
2
·1mm.
3
·25mm.
4
·75mm.
5
·05mm.

Craspedoxantha indica sp. nov.

Adult male ; 2. Aedeagus (lateral view) ; 3. Genitalia (lateral view) ;
Head (lateral view) ; 5. Sense organ, enlarged.

The moth is orange-brown, with the forewing crossed by a black curved antimedial line and irregularly undulated postmedial line, which curves below and touches a black streak. The hind wing is crossed by two medial blackish wavy lines and a marginal line in black. Outer borders of the wings are darkest in colour. The fore legs are whitish with black bands. The wing expanse is 6/10-7/10 in. (*c.* 15-17 mm.).

ECONOMIC STATUS

The insect appeared in large numbers on a bed of mint in the orchard and completely damaged the crop in one month. It occurred in May and June by which time all the plants had been affected. It thus seems to be a serious pest of the crop.

ACKNOWLEDGEMENT

The authors are thankful to Dr. S. Kanakaraj David, Reader in Entomology, Post-Graduate Training Centre, Coimbatore, for having given valuable suggestions in preparing this paper.

POST-GRADUATE TRAINING CENTRE,
COIMBATORE-3,
July 7, 1960.

A. ABDUL KAREEM
S. JAYARAJ
P. P. VASUDEVA MENON

REFERENCES

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Zacker, F. (1913): 'African Cotton Pests.' Arbeit. K. biol. Anst. Land- und Forstwirts Chaft, Berlin, IX, No. 1, 1913, pp. 121-230.

21. A NEW SPECIES OF THE GENUS *CRASPEDOXANTHA* BEZZI, 1913, FROM INDIA (DIPTERA: TRYPETIDAE)

(*With a plate*)

The genus *Craspedoxantha* was first erected by Bezzi in 1913 with *Craspedoxantha octopunctata* as the type. The description of the genus was based upon a single female specimen from the Dawna Hills (Lower Burma), collected in 1908. This species was subsequently recorded from Bangalore (Senior-White 1922) and from Delhi (Bhatia 1939) and I am glad to be able to describe a new species.

Craspedoxantha indica sp. nov.

MALE. General coloration of the body cream-yellow; length of body 4.13 mm.; wing 4.62 mm. long, 1.47 mm. broad, 3.14 times as long as broad.

Head. Length, width, and height of the head, 0.86 mm., 1.44 mm., and 1.19 mm. respectively; frons slightly convex, 0.57 mm. long, 0.75 mm. wide, 1.2 times as long as the maximum width of either eye; face concave; eyes scarlet-red, sharply contrasting with the cream-yellow colour of the head; each eye in profile 0.92 mm. high and 0.48 mm. wide, 1.9 times as high as wide; third antennal segment with its ventral side gently curving towards the dorsal apex; length of second segment 0.19 mm., length of third segment 0.29 mm., the third segment 1.5 times longer than the second; the antennal segments concolorous with the head, arista brown and 0.38 mm. long; proboscis capitate; maxillary palpi moderately broad with a few very fine yellow bristles; premental plate (theca) concolorous with the proboscis which is cream-yellow; ocellars yellow; lower orbitals three, yellow; upper orbitals two, yellow; inner verticals yellow; outer verticals yellow; postocellars pale, scale-like; postverticals pale, scale-like; postorbitals (occipital row) consisting of approximately ten, pale scale-like, small bristles; genals yellow.

Thorax. Dorsum of thorax light reddish yellow and covered with very short white hairs; the notopleural calli, the humeral calli, the pleurae, and the scutellum cream-yellow; mesosterna and metasterna reddish yellow; prosternum cream-yellow; scutellum 0.42 mm. long, 0.81 mm. wide, the apical half of the scutellum bearing small, dark brown hairs; two pairs of black spots forming a square in the middle of the dorsum of thorax behind the suture and bearing the dorsocentral and prescutellar bristles; one black spot just postero-ventral to the presutural bristle; one black spot ventral to the anterior supra-alar bristle; one black spot posterior to the first posterior supra-alar bristle, situated between the latter and the basal angle of the scutellum; one black spot just postero-dorsal to the wing-base; a pair of black, coalesced spots at the antero-mesal aspect of the mesosternum; legs cream-yellow; fore femora underneath with a longitudinal row of seven strong yellow bristles, dorsally with two longitudinal rows of moderately developed bristles; hind femora with four asymmetrically placed yellow bristles on the dorsal side near the end; hind tibiae with a comb-like row of stout, yellow bristles situated longitudinally on the dorsal side and pointing anteriorly; scapulars with no definite number; humerals pale; anterior notopleurals pale; posterior notopleurals pale; presuturals pale; dorsocentrals pale, situated slightly anteriorly to the anterior supra-alars and longitudinally in line with the prescutellars; anterior supra-alars pale; posterior supra-alars two pale; mesopleural, pteropleural, and sternopleural pale, one each; scutellars four pale; wings with all the veins, except the second brown-yellow; second vein creamy-white; first vein bristly; third vein bare, but with a few (approximately four) bristles at the base; costal bristles two, one of them being comparatively smaller; wing pattern as shown in the figure.

Abdomen. Colour of abdomen cream-yellow, the terga being slightly darker; first tergum abundantly clothed with short white hairs, the rest of terga with dark brown hairs, which are stouter along the lateral margins; pregenital part of the abdomen 1.69 mm. long, 1.67 mm. wide, 0.67 mm. wide at the base; fifth tergum 0.57 mm. long, equal to the preceding two terga in length; the genital segments also cream-yellow, except the black teeth of the outer claspers; a black spot on each antero-lateral angle of terga 3 to 5, the spot on tergum 3 being more or less concealed by the preceding tergum, the spots on terga 4 and 5 being partly so; a black spot on anterior margin of terga 3 and 4 close to the mid-longitudinal line of the abdomen, the spots on tergum 3 being more or less concealed by the tergum preceding, those on the tergum 4 are partly so; a moderately broad black border along the anterior margin of tergum 5, bluntly interrupted in the middle and tapering laterally towards the black spot at the antero-lateral angle of tergum 5; a black spot on postero-lateral angle of tergum 5 bearing a bristle; surstyli not bifid or lobate; the genital ring with a hood-like structure in its anterior one-third; flutella pronged; the details of the genital structures and the aedeagus as shown in the figures.

FEMALE: Unknown.

HOLOTYPE: One male, in personal collection (ZR 1), collected while sitting on the leaves of *Xanthium strumarium* (Compositae), 4.7.1959.

HOST: Unknown.

LOCALITY: University Campus, Aligarh, India.

DISCUSSION

This species resembles *Craspedoxantha octopunctata* Bezzi in its 8 black spots on the thorax, and in the wing pattern, but it differs in the following characters:

1. 12 black spots on the abdomen (besides a black border along

the anterior margin of the fifth tergum); in the genotype the abdomen is uniformly reddish yellow.

2. The thorax is light reddish yellow and not dark ferruginous.
3. The scutellum is cream-yellow and not dark ferruginous.
4. The occiput is pale without any grey pollen.
5. There are two upper orbitals instead of one (in this connection a re-examination of the genotype is highly desirable which unfortunately is not available).
6. The 2nd vein is creamy-white and not yellow.
7. A double longitudinal row of bristles on the dorsal side of the fore femora.
8. Four asymmetrically placed bristles on the dorsal side of the hind femora near the end.

ACKNOWLEDGEMENTS

The author takes this opportunity to express his grateful thanks to Prof. M. B. Mirza for providing all facilities in his department, and to Dr. S. M. Alam for his interest and encouragement.

DEPARTMENT OF ZOOLOGY,
ALIGARH MUSLIM UNIVERSITY,
ALIGARH,
August 4, 1960.

MD. ZAKA-UR-RAB

REFERENCE

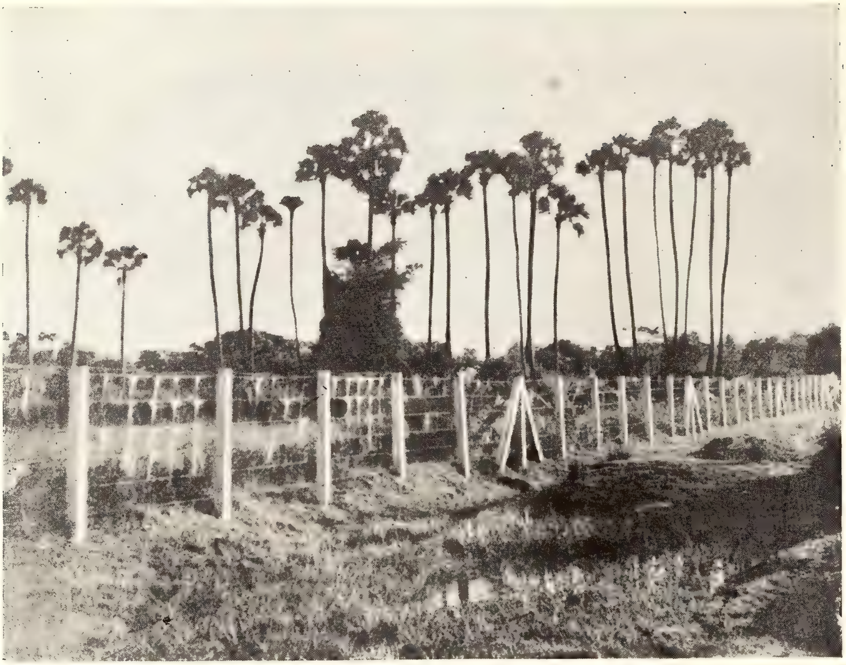
Bezzi, M. (1913): Indian Trypaneids (Fruit-flies) in the collection of the Indian Museum. *Mem. Indian Mus.*, Calcutta **3**: 156-157.

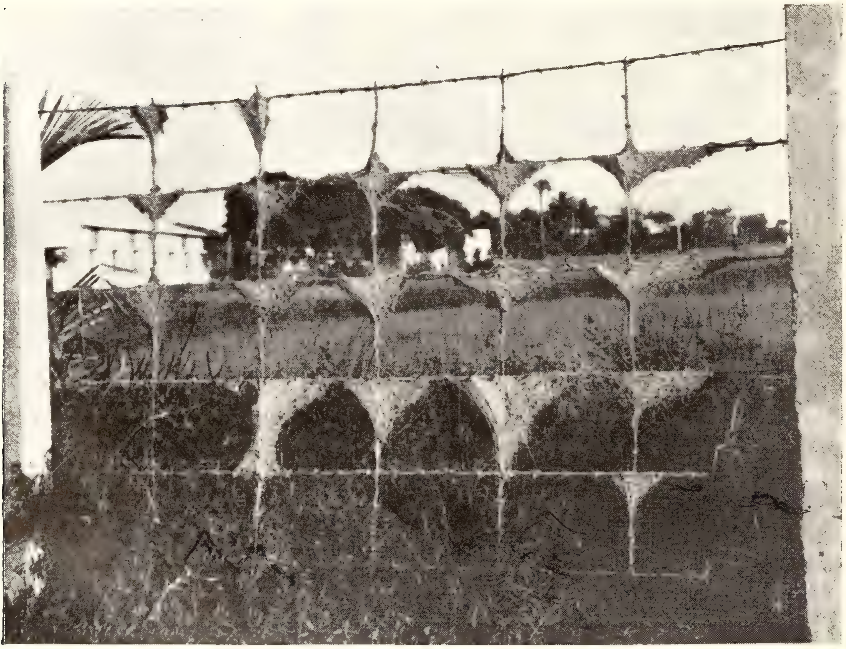
22. UNUSUAL NEST-SITE OF THE SOCIAL SPIDER, *STEGODYPHUS SARASINORUM* KARSCH

(*With a plate*)

The nest of the Social Spider, *Stegodyphus sarasinorum* Karsch (Family Erisidae), is a familiar sight in the scrub jungles of Tambaram. The nests are usually constructed on shrubs and trees with a preference for those with thorns and for rough-stemmed plants, like *Grewia* (Tiliaceae) and *Atalantia* (Rutaceae), and more rarely on the prickly pear plant as observed by Jambunathan (1905) and Savory (1928).

An unusual nest building site was noticed by me on the barbed wire fencing of a compound about a mile north of Tambaram. Here





Nests of the Social Spider, *Stegodyphus sarasinorum* Karsch.

the nests were 65 in number, of which about 50 were inhabited and the rest deserted. The nests were built round the crossing of the barbed wires, and the houses had a compact laterally compressed triangular shape, with an average thickness of 20 to 25 mm. and the edges almost touching each other.

Although the barbed wire fencing extended to over 300 yards (*c.* 275 m.) all the nests were close together and built on adjacent wire crossings. The house was in the centre with several openings all round, but the net-like expansion with sticky threads covered the intervening space between the wires.

Each nest was inhabited by about 40 individuals on an average, with more males than females. The males were smaller (6 mm.) than the females (8 to 9 mm.). Both the sexes were of ashy grey colour resembling the surroundings, i.e. the colour of the nest. They were found to be more active just before dusk and at night. When an ant was thrown on the nest several of them came out to drag it in. The study of the exoskeletal remains of insects found in the nest could be a study by itself and would give a clue to the insect fauna in that locality. Remains of Chrysomelid beetles, dung-rollers, water beetles, termites, plant bugs, noctuid moths, and flying ants are among the more common ones, and some of their exoskeletons are preserved almost entire, making identification easy.

The month of March seems to be a period of prosperity and breeding for these spiders. In every nest were found 5 to 9 egg-cases. Each egg-case, a circular disc of fine silk and 4.5 mm. in diameter, was left stuck to the inner wall of the house. These were invariably guarded by females, who took up a threatening attitude when disturbed. Some nests had newly hatched young, which were also guarded in a similar way by the females.

These observations were made while going round on the survey of the Arachnida of Tambaram and its environs, which was undertaken with a grant for field work from the Bombay Natural History Society.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE,
TAMBARAM, CHINGLEPUT DIST.,
July 9, 1960.

G. J. PHANUEL

REFERENCES

Jambunathan, N.S. (1905): The habits and life history of a Social Spider, *Stegodyphus sarasinorum* Karsch. *Smithsonian Misc. Coll.* 47, No. 1573, : 365-372.

Savory, Theodore H. (1928) : The Biology of Spiders. London.

[C. E. C. Fischer in a note on this species (*J. Bombay nat. Hist. Soc.* **18** : 207) stated that he had no evidence of these spiders attacking any insects struggling in the web and believed that they either allowed the trapped insects to die or waited till it was quite helpless with starvation.—EDS.]

23. AN UNUSUAL METHOD OF CURING SCORPION STINGS

My attention has been drawn to a note in *The Times* of the 13th June 1960 (late London air edition) entitled 'An Indian Painkiller'. When the correspondent, probably an ex-I.C.S. man, was sitting with one Agarwal, a Dy. Magistrate in Saharanpur, he was stung by a brown wasp. Agarwal offered to cure him with a none too clean steel-bladed paper-knife and the correspondent hesitatingly agreed. With the knife point held flat under his forefinger, Agarwal criss-crossed slowly and steadily the area of the sting, firmly scratching but never breaking the surface. Each time he was careful to ensure that the knife point crossed the exact point of entry of the sting and with each stroke the correspondent felt relieved. After a dozen passes or so, the pain had virtually disappeared. Subsequently, the correspondent used this cure successfully for scorpion and wasp stings. He also mentions an instance when his treatment was interrupted by a Sub-inspector of Police who, by similar methods, 'put back' the pain! This was however removed a few minutes later in the same fashion and one is left with the impression that the pain could be 'switched' on and off!

This reminds me of a similar experience.

About 30 years ago a cousin F. H. B. Tyabji started farming near Ahmednagar in the Bombay-Deccan. The area was a wilderness and very little medical attention was then available. Under these circumstances my cousin, with a bottle of iodine and a few standard mixtures, soon became the local doctor. Among the many complaints of various kinds which were brought to him, he found that scorpion sting was a constant occurrence. About this time, he was informed that certain signs accompanied by verses from the Koran would cure the pain and he decided to give it a trial.

A rectangle was to be drawn complete with diagonals and a triangle at the top, without lifting the instrument off the skin, the Arabic lines being recited throughout the performance.

The response was instantaneous and amazing. At the first performance the pain was said to have dropped for an appreciable distance and, if repeated two or three times, disappeared completely. A person literally writhing with pain would turn up at the farm to be treated and return happy and cured within a few minutes. Tyabji's fame spread far and wide and victims crowded to him for the 'miraculous' cure. With more experience he noticed that the designs did not have to be very carefully drawn and that he could skip portions of the prayer. Later, he would merely make passes with his hands and omit the recitations, but the cure worked just the same. I understand that he treated hundreds of cases and failures to relieve pain were very rare.

This is not all and I have an experience of my own to relate which occurred in 1948, at Chikalda. Returning from a morning's walk, I found the khansama in great agony, having been stung on the hand by a scorpion and the pain having gone up to his shoulder. On the table lay a scalpel, which I had been using for skinning birds. I picked it up and seized the victim's arm. Fearing, perhaps, some sort of amputation, the khansama shrank from me, but I merely made some passes over his shoulder, barely touching the skin. My inquiry regarding the efficacy of the cure was met by a blank stare, but I repeated my actions and was told that the pain had dropped to the elbow. A few more passes had the man completely cured, except for slight discomfort at the initial puncture. My wife was present and I do not know which of us three was the most surprised at what had happened.

I have not had another opportunity to try out this cure, but am surprised that it is not better known and has not been more closely investigated by the medical profession. I have no explanation to offer.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
August 1, 1960.

HUMAYUN ABDULALI

[Fr. H. Santapau, Joint Editor, writes:

'The late Rev. J. F. Caius, Vice-President and member of the editorial board of the Bombay Natural History Society, jointly with Dr. M. S. Mhaskar published a lengthy paper on 'Notes on Indian Scorpions' in the *Indian Med. Res. Mem.* **24** : 1-102, 1932. In the preparation of the paper, the authors studied a very large number of herbal preparations commonly used in India in the treatment of scorpion sting. Of these preparations Caius and Mhaskar write: 'None of the Indian Plant Remedies popularly used in the treatment of scorpion sting has been found to have any preventive, antidotal, or therapeutic effect'.

'I asked Fr. Caius what then could be done for scorpion stings. His answer confirmed the facts mentioned by Shri H. Abdulali in the preceding note. The most acute pain is felt in the nerve ganglia in the upper arm or upper leg. Fr. Caius informed me that, using a needle or even a pointed pencil, one should make a series of scratches (without cutting the skin) beginning from the point of greatest pain; from there the scratches are to be repeated about every inch downwards to the tip of the fingers or of the toes. The scratching of the skin distracts the attention of the sufferer, so that by the time the last scratch has been made near the tip of the arm or leg, the pain has disappeared.

'In my personal experience I have found that alcohol or methylated spirit, ammonia, or even kerosene oil applied to the hand or foot and allowed to evaporate may produce the same pain-killing effects.

'One thing should be kept in mind when stung by a scorpion. 'Scorpion sting is very rarely fatal; and thus scorpions are no more dangerous to human beings than bees or wasps.' (Caius & Mhaskar, p. 98). Some of the deaths recorded in the past as due to scorpion sting are in all probability mostly due to the vivid imagination of the sufferer. The maximum amount of venom found by Caius and Mhaskar in the common Indian scorpion, *Buthus tamulus*, was only 5.3 mg.; if the toxicity of the venom in relation to body weight was the same for man as for the very susceptible English rabbit, the total quantity mentioned above would not be lethal for a greater body-weight than 2.6 kg. Scorpion venom should then not be lethal to man, children not excepted'.—EDS.]

24. A NEW SPECIES OF MOLLUSC, *GULELLA RAMBHAENSIS*, FROM RAMBHA IN ORISSA (GASTROPODA: FAMILY STREPTAXIDAE)[1]

(*With one text-figure*)

Gulella (Huttonella) rambhaensis sp. nov.

Material: One broken land shell found along with other specimens in debris lying on the beach of Rambha Bay of the Chilka

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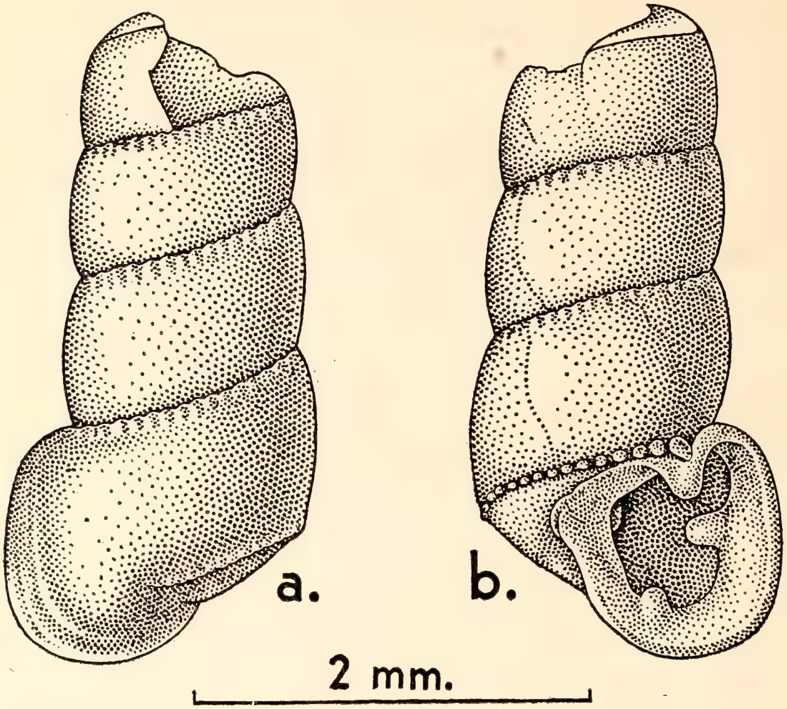
[1] Communicated by the Director, Zoological Survey of India, Calcutta.

Lake, Ganjam District, Orissa, about 0.4 km. west of Rambha Dak Bungalow and 4.8 metres above the water margin.

Though the spire is only partly broken, other essential parts which remained intact, such as bodywhorl, penultimate whorl, peristome and armature of the mouth, show the characteristic features of the genus *Gulella* Pfeiffer (1856). Besides, further study reveals such remarkable features as are seldom met with in any known species of this genus. Hence, I propose for it the new name *rambhaensis*.

Diagnosis: Shell tiny, fragile, perforate, cylindrically-turreted, dextral, smooth, polished but not shining, white (but it seems that the colour was pale cream when fresh), devoid of costulations; spire partly broken, but much narrower than in *G. bicolor* and its var. *barkudensis*; whorls only 4 (the rest, possibly 3 or 4, being entirely lost with the broken upper part of the shell), slightly convex, bodywhorl adnate as in the above two (i.e. closely connected with the penultimate whorl, though not free), larger and produced outwards, greater in width than in length, distinctly carinate at the base—the carina ending a little before the extremity marked with 2 or 3 vertical lines of growth; sutures impressed and crenulate—crenulations appearing more prominent and bead-like on the ventral side of the last suture, but gradually diminishing in size while passing round the dorsum of the bodywhorl along the carina, and ultimately terminating with it at the base; peristome white, thickened, expanded, continuous, reflected, rounded at the base somewhat as in var. *barkudensis*, truncated above, outer margin more regularly curved and expanded in the absence of external fosset, and hence extending even beyond the general outline of the body of the shell itself; parietal lamina prominent and looking somewhat like the upper part of the human ear, and ascending just above the last suture only; actual orifice trilobed—the largest lobe median and lying on the columellar side, in between the parietal tooth above and the basal tooth at the left corner below, with the other two on the outer side, the smallest lobe lying above at the upper angle and the intermediate lobe at the lower angle in between the median outer marginal tooth (or palatal tooth) and the basal tooth; parietal and palatal teeth appearing more or less equally strong, basal tooth smaller and less strong than both, but columellar plica smallest of all, deep-seated, somewhat depressed and lying just behind the largest lobe on the throat of the columella; umbilicus only slit-like and concealed from view by the expanded peristome and hence should be carefully seen from a profile view.



Shell of *Gulella* (*Huttonella*) *rambhaensis* sp. nov., from Rambha, Orissa
(a) Dorsal view; (b) Ventral view.

Measurements:

(i) Length of the broken shell	3.2 mm.
(ii) Diameter of the broken shell (round the penultimate whorl)	1.3 mm.
(iii) Length of the bodywhorl	1.2 mm.
(iv) Diameter of the bodywhorl	1.7 mm.
(v) Length of the peristome	1.0 mm.
(vi) Diameter of the peristome	1.0 mm.
(vii) Length of the actual orifice	0.8 mm.
(viii) Diameter of the actual orifice	0.5 mm.

Type specimen: Holotype. Regd. No. M 16593/2, Zoological Survey of India, Calcutta.

Type locality: Beach of Rambha Bay of the Chilka Lake at Rambha, Ganjam District, Orissa. Coll. Dr. H. C. Ray. 6-1-55.

Remarks: The new species, *G.* (*H.*) *rambhaensis*, may be closely allied to *G. bicolor* (Hutton, 1834), the most widely distributed land snail originally known from Mirzapur, U.P., and its var. *barkudensis* (Annandale & Prashad, 1920) from the Barkuda Island in Chilka

Lake, Orissa, but differs markedly from both in having the shell perforate and its spire much narrower, bodywhorl slightly more produced outwards and carinate at the base, crenulations more prominent and bead-like on the ventral side of the last suture and continued even to the base along the carina, peristome continuous and its outer margin regularly curved and more extended outwards in the absence of external fosset. For further details about *G. bicolor*, the papers of Benthem Jutting (1950) and Blanford & Godwin-Austen (1908) may be consulted.

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE,
CALCUTTA-12,
September 14, 1960.

H. C. RAY,
M.SC., D.Phil., F.Z.S.I.

REFERENCES

Annandale, N. & Prashad, B. (1920): *Rec. Ind. Mus.* **19**(5): 189-191 (*E. bicolor*), 191-194 (var. *barkudensis*).

Benthem Jutting, W. S. S. (1950): *Treubia* **20**: 504-505.

Blanford, W. T. & Godwin-Austen, H. H. (1908): Fauna Brit. Ind., Moll. (*Testacellidae* and *Zonitidae*): 19-21.

Hutton, T. (1834): *J. As. Soc. Bengal*, **3**. 86-93 (*Pupa bicolor*).

Pfeiffer, L. (1856): *Malakozool. Blatt.* **2**: 173 (*Gulella*), 174 (*Huttonella* and species *bicolor*).

25. ECTOPROCTAN-COELENTERATE ASSOCIATION: AN EXAMPLE OF UNPURPOSEFUL INQUILINISM?

While examining a catch of fishes for parasites I came across a specimen of the crustacean cymothoid isopod, *Nerocila trivittata* Bleeker, attached to the dorsal side of the fish *Otolithus argenteus*. The posterior part of the body of the parasite appeared to be covered with foreign matter which, on repeated washing, did not peel off. Consequently the specimen was examined under the microscope. What looked like dirt turned out to be an encrustation of the coelenterate hydroid, *Clytia gracilis*, with a close matting of an ectoproctan, amidst the horizontal stolons.

As observed by Dales (*Geological Society of America*, Mem. 67, p. 391, 1951) interpretation of commensalic associations is peculiarly susceptible to anthropomorphic bias, particularly because of the difficulty of applying experimental methods to determine the degree of dependence of the commensals. Hence exceptions, like the present, have importance.

Associations between animals and plants or between animals of widely different groups are described, often casually, as mutualism (symbiosis), commensalism, and inquilinism. Many sedentary animals, particularly hydroids and polyzoans, are epizoic on, i.e. they live attached to, other animals or plants, but are not parasites on them. There are records of hydroids growing on other coelenterates, polychaetes, decapods, molluscs, and fishes (Dales, op. cit.). The present record adds another, quite an unconventional one, to the list of hosts. To my knowledge a parasitic isopod has not previously been known as the host of a commensalic hydroid or ectoproctan. But the parasitic copepod, *Sarcotretes scopeli*, has been recorded harbouring the hydroid, *Ichthyocodium sarcotretis* (Jungerson, *Vidensk. Meddel. naturh. Foren.* Vol. 64, 1911). Hence, it is interesting to speculate on the origin of the association.

Many of these associations have their origin in the crowded condition of the littoral and sublittoral zones. Also, in muddy or sandy areas the only hard objects available to sedentary animals are other animals. Here competition is mainly for living space, to secure a foothold. Epizoics get attached, at random, to any solid substratum, motile or sedentary. Hence, all associations, even the most specific ones, must have originated quite accidentally. Specificity is the result of natural selection.

Nerocila has a short free-swimming existence during its male phase, but soon contacts a suitable host and metamorphoses into a female. As the fish in question is neither littoral nor sublittoral in the strict sense, the association must have started in the pelagic environment. It is well known that larvae of most sedentary organisms have a definite larval period, at the end of which they must settle or perish. In the present case the hydroid larva, compelled by necessity settled on the isopod. It has to be admitted that the isopod host is certainly more suitable than a sedentary animal or an inanimate object, as the hydroid would certainly benefit by the movement of the fish host and also get the advantage of a sedentary life. Obviously the ectoproctan is the latest guest, for usually nothing settles over a live ectoproctan colony. It is likely that the encrusting hydrorhizae of the coelenterate provided the necessary purchase for the polyzoan.

The present discovery shows that any hard surface is utilised by the larvae of sedentary organisms and the choice is solely dependent on the exigencies of circumstances. The present example should be classed as fortuitous association or 'unpurposeful inquilinism'.

MARINE BIOLOGICAL LABORATORY,
TRIVANDRUM,
July 19, 1960.

N. KRISHNA PILLAI

26. THE CORRECT NAME OF *CASSIA GLAUCA* AND ITS VARIETIES

The plant, commonly known in India as *Cassia glauca*, is a shrub or a small tree with attractive yellow or orange flowers. This plant drew the attention of some of the pioneer botanists who worked on Indian plants in the seventeenth and eighteenth centuries. Rheede (1686) described this plant under the name *Wellia-tagera* and gave two good illustrations. Burman (1768) described the plant and named it *Cassia surattensis.* The plant was described as having eight pairs of leaflets with obtuse apices and bright orange-coloured flowers. The description of the plant was based on a specimen from Garzin's herbarium and probably for this reason no reference to Rheede's *Wellia-tagera* was given. A few years later, Lamarck (1789) described the plant as *Cassia glauca*, and Vahl (1794) named it *Cassia arborescens.* Both Lamarck and Vahl have referred to Rheede's description and plate. Burman's name, *Cassia surattensis*, being earlier and conspecific with *Cassia glauca* and *Cassia arborescens*, must be accepted as the valid name for this plant. Bentham (1871), in his revision of the genus *Cassia*, agreed that all these names refer to the same species, but somehow he accepted the name *Cassia glauca.* Merrill (1923), however, indicated that the name *Cassia surattensis* should receive priority over *Cassia glauca.* In recent publications of Raizada & Hingorani (1954), the name *Cassia surattensis* has been accepted.

It would have been unnecessary to prepare this note if there was unanimity of opinion on the lines suggested above. But unfortunately, it is not so. Bailey (1949) considered that *Cassia planisiliqua*, which was published much earlier by Linnaeus himself, should be the valid name of this plant. He supported this with two earlier publications by Grisebach (1864) and by Britton & Rose (1930). The latter authors not only considered *Cassia glauca* the same as *Cassia planisiliqua*, but further decided to place the plant under a newly created genus which they named *Psilorhegma* and the plant was named *Psilorhegma planisiliqua* (Linn.) Britt. & Rose. The new genus was apparently created in view of such characters as ten perfect stamens in flowers, flat pods, and glanduliferous leaves. It was however felt that in general appearance the plant agrees very well with *Cassia* and the creation of the new genus (and thereby removing the plant from the genus *Cassia*) is a step which is rather artificial. As a matter of fact, Bailey (1949) has correctly restored *Psilorhegma* back to *Cassia*, which should be its natural and rightful place.

After a study of the available literature, it is clear that the name *Cassia planisiliqua* as accepted by Bailey cannot be considered for this plant. According to Bentham (1871), who examined the specimen of *Cassia planisiliqua* at the Linnean Herbarium and the original plates of Plumier on which the description was mainly based, the name *Cassia planisiliqua* is to be regarded as a *nomen confusum.* The Linnean diagnosis of the species given in his SPECIES PLANTARUM refers to *Cassia occidentalis.* The plate referred to by Linnaeus (i.e. Plumier ed. Burm. t. 77) is unfortunately a mixture of two or three species and does not refer at all to any known species of *Cassia.* According to Bentham: 'The leaves are those of *Cassia fistula*, the flowers quite unintelligible, the fruit more like that of section *fistula* than of any other, described as flat, whence the name, but figured as nearly terete and filled with a series of unintelligible circles described as *ossicles* or seeds, but more likely to be the transverse septa of the *fistula* section as they overlap each other. The whole species must, therefore, be passed over as an inexplicable puzzle, founded on the diagnosis of one species, with the representation of another, cooked up by an inaccurate artist, and encumbered by the description of the fruit of a third species. The plant representing *C. planisiliqua* in the Linnean Herbarium is *C. siamea*, which is certainly not the one from which he took his diagnosis.'

It would, therefore, be clear that the evidence against accepting the name *Cassia planisiliqua* is overwhelming and this name has to be rejected from our consideration. We have, therefore, to accept the next validly published name, *Cassia surattensis* Burm. f., as the name for this plant. The species has two well-marked varieties, i.e. (i) var. *surrattensis* and (ii) var. *suffruticosa.* These two varieties were considered by some as distinct species. Bentham (1871, p. 555), on the other hand, found it difficult to separate the Indian collection into two distinct varieties. He has, however, admitted the existence of two 'types' as he said: 'The Australian specimens belong to the *suffruticosa* type; they are much more variable than the Indian ones, but not in the direction of the large *glauca* type.' From an examination of herbarium specimens, these two 'types' are clearly distinguishable and should be considered as two varieties. Important points of difference between the two varieties are the presence of more numerous and smaller leaflets and strongly unequal petals in var. *suffruticosa*. The nomenclature and descriptions of these varieties with their distribution are as follows:

(i) **Cassia surattensis** Burm. f. var. **surattensis**. *Cassia surattensis* Burm. f. Fl. Ind. 97 (1768). *C. glauca* Lam. Encycl. 1: 647 (1789). *C. arborescens* Vahl (non Mill.) Symb. Bot. 3: 56 (1794). *C. discolor* Desv. Journ. Bot. 3: 73 (1814). *C. sulphurea* DC. Prodr. 2: 495 (1825). *Senna arborescens* Roxb. Fl. Ind. 2: 345 (1832).

A small tree 5 to 6.5 m.; young branches minutely pubescent becoming glabrous later; stipules subulate, acuminate, 1 cm. long; petiole 2 to 5.5 cm. long, glabrescent; rachis thinly pubescent or glabrous, with 2 or 3 short, stout, clavate glands in between lower pairs of leaflets (one gland between each lower pair); leaves equally pinnate, 15 to 22 cm. long; leaflets 4 to 6 pairs, elliptic or oblong-elliptic, ovate, entire, subacute, pinnate-reticulate veined, almost glabrous, glaucous beneath, 5-10 cm. long, 2.5-4 cm. wide; peduncles axillary, 6 to 10 cm. long; pedicels 2-3 cm. long; flowers corymbose, sepals ovate or elliptic, rounded, unequal, 8 to 10 mm.; petals 5, subequal, spreading, broadly ovate-obtuse, 2 to 3 cm. long, bright yellow-orange; stamens 10, anthers all equal and fertile, two with longer filaments; pods flat, straight, drooping, glabrous, 10 to 17 cm. long, 1.5 cm. wide, margin raised; seeds biseriate 20 to 30, oval, testa dark brown.

Distribution: India, Burma, Ceylon, Malaya, southern China, Formosa, Sumatra, tropical Australia. Cultivated also in many countries.

(ii) **Cassia surattensis** Burm. f. var. **suffruticosa** (Koen. ex Roth) Chatterjee comb. nov. *C. speciosa* Roxb. Hort. Beng. 31 (1814) nomen. *C. suffruticosa* Koen. ex Roth, Nov. Pl. Sp. 213 (1821); Koen. ex Roth in DC. Prodr. 2: 496 (1825); W. & A. Prod. 289 (1834); Benth. Fl. Austral. 2: 285 (1864). *C. horsfieldii* Miq. Fl. Ind. Bat. 1: 99 (1855). *Senna speciosa* Roxb. Fl. Ind. 2: 347 (1832). *Cassia acclinis* F. Muell. Fragm. 4: 13 (1864). *C. glauca* Lam. var. *suffruticosa* (Koen.) Baker in Hook. f. Fl. Brit. Ind. 2: 265 (1878). *Psilorhegma suffruticosa* (Koen.) Britton in North Am. Fl. 23: 255 (1930).

Cassia fastigiata Vahl (Symb. Bot. 3. 57, 1794) excl. descr. '*glandulis inter omnia paria*' probably belongs here as indicated by Wight and Arnott (*Prod.* 290, 1834) and Prain (*J. As. Soc. Bengal* 66: 477, 1897).

The varietal name *Cassia glauca* Lam. var. *suffruticosa* (Koen.) Baker (Hook. f. Fl. Brit. Ind. 2: 265, 1878) appears to be wrongly ascribed to Prain in Gamble's Flora of Madras (403, 1919) instead of to Baker.

It may be of interest to note that Fischer (*Kew Bull.* 1932: 56) examined Koenig's specimens from India now kept at the Lund Herbarium but did not find any specimen of *Cassia surattensis* or *Cassia glauca.*

A tall shrub or a small tree; young branches adpressedly pubescent, older twigs glabrous; stipules subulate, 1 cm. long; petioles 2 to 3 cm. long, glabrescent; rachis thinly pubescent with 2 or 3, erect, clavate glands, located on the lower part of rachis (one gland in between each pair of leaflets); leaflets 6 to 10 pairs, obovate oblong, obtuse or rounded, finely pinnate-reticulate, 2 to 4.5 cm. long, 1 to 1.5 cm. wide, upper surface glabrous, lower glaucous minutely pubescent; peduncles axillary, 2 to 6 cm. long; inflorescence corymbose; pedicels about 2 cm. long; sepals 7 mm., elliptic; petals 1.5 to 2 cm. long, distinctly unequal; stamens 10, all equal and perfect, lower two on longer filaments; pods 6 to 10 cm. long, 8 to 12 mm. wide, glabrescent, margin raised.

Distribution: India, Burma, Malaya, Java, Australia. Cultivated in many countries.

INDIAN BOTANIC GARDEN,
CALCUTTA,
August 19, 1960.

D. CHATTERJEE

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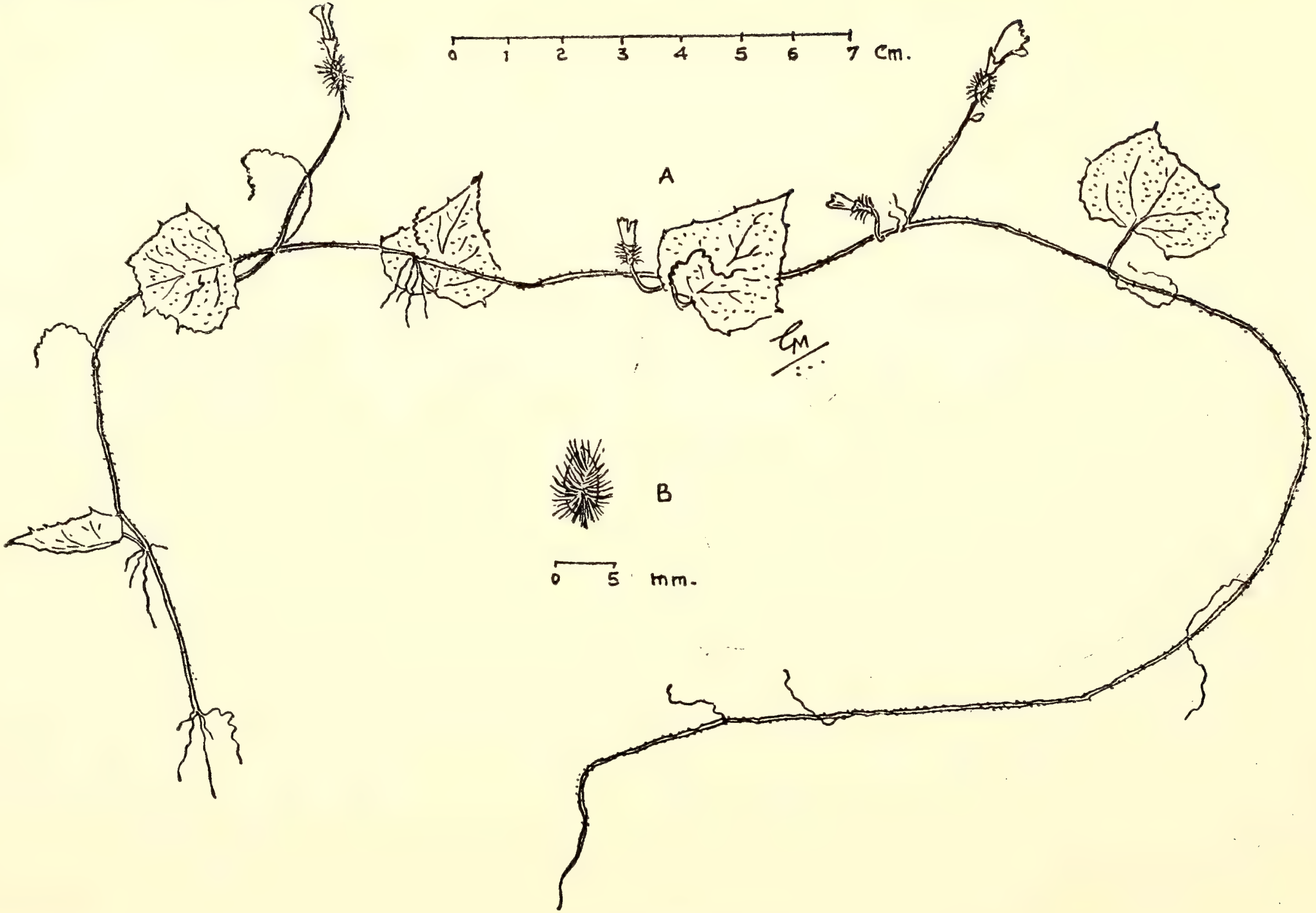

0 1 2 3 4 5 6 7 Cm.
A
B
0 5 mm.

Cucumis setosus Cogn.
A. Flowering branch; B. Fruit.

27. *CUCUMIS SETOSUS* COGN.—A NEW RECORD FOR BOMBAY

(*With one plate*)

In our exploration of Pavagadh Hill, 46.6 km. NE. of Baroda, we have come across a cucurbit which is not described in our common floras. Chakravarty (1959) in his recent monograph on the Indian Cucurbitaceae describes this plant. A few notes on the distribution of the same are interesting.

Cucumis setosus Cogn. in DC. Monog. Phan. 3: 491. 1881; Chakravarty, Mon. Ind. Cucur. 106, f. 44, A-D & f. 45, map 51, 1959.

A slender climber, monoecious. Stem furrowed, clothed with minute coarse hairs. Tendrils slender. Leaves 2-2.4×2.1-2.6 cm., membranous, deltoid, feeling roughish to the touch, acute, minutely dentate, 3-lobed, 5-nerved, petiole 6-9 mm. long. Flowers small, solitary, yellowish. Calyx tube campanulate, hairy. Corolla glabrous. Ovary globose, oblong; covered with short soft hairs. Fruit setose (covered with bristles).

Flowering and Fruiting: 26th September 1959.

Records from India: (*a*) Chakravarty lists two specimens for India. 'In Eastern India (*Ritchie* 321 Herb. Edin.); without precise locality, probably peninsular India (Witt, no. 191 A. 5-D,25/10/12 Herb. Cal.).' (*b*) The specimen referred to in the present note was collected by the junior author from Pavagadh, in the forest at an altitude of 461 m. on 26-9-1959, and is preserved in the Herbarium, Department of Botany, M.S. University of Baroda.

Index Kewensis gives India as the home of this plant. Chakravarty, loc. cit., mentions only two sheets so far available. Of these two sheets, the one of Ritchie is from eastern India and that of Witt is *probably* from peninsular India without any further details.

The plant seems to be endemic in S. India; it has not been recorded from Bombay. It is, therefore, a new record.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
July 25, 1960.

A. R. CHAVAN
G. M. OZA

28. PHYLLODY OF THE GYNOECIUM AND ANDROECIUM IN YLANG-YLANG TREE, *CANANGA ODORATA* HOOK.

(*With a plate*)

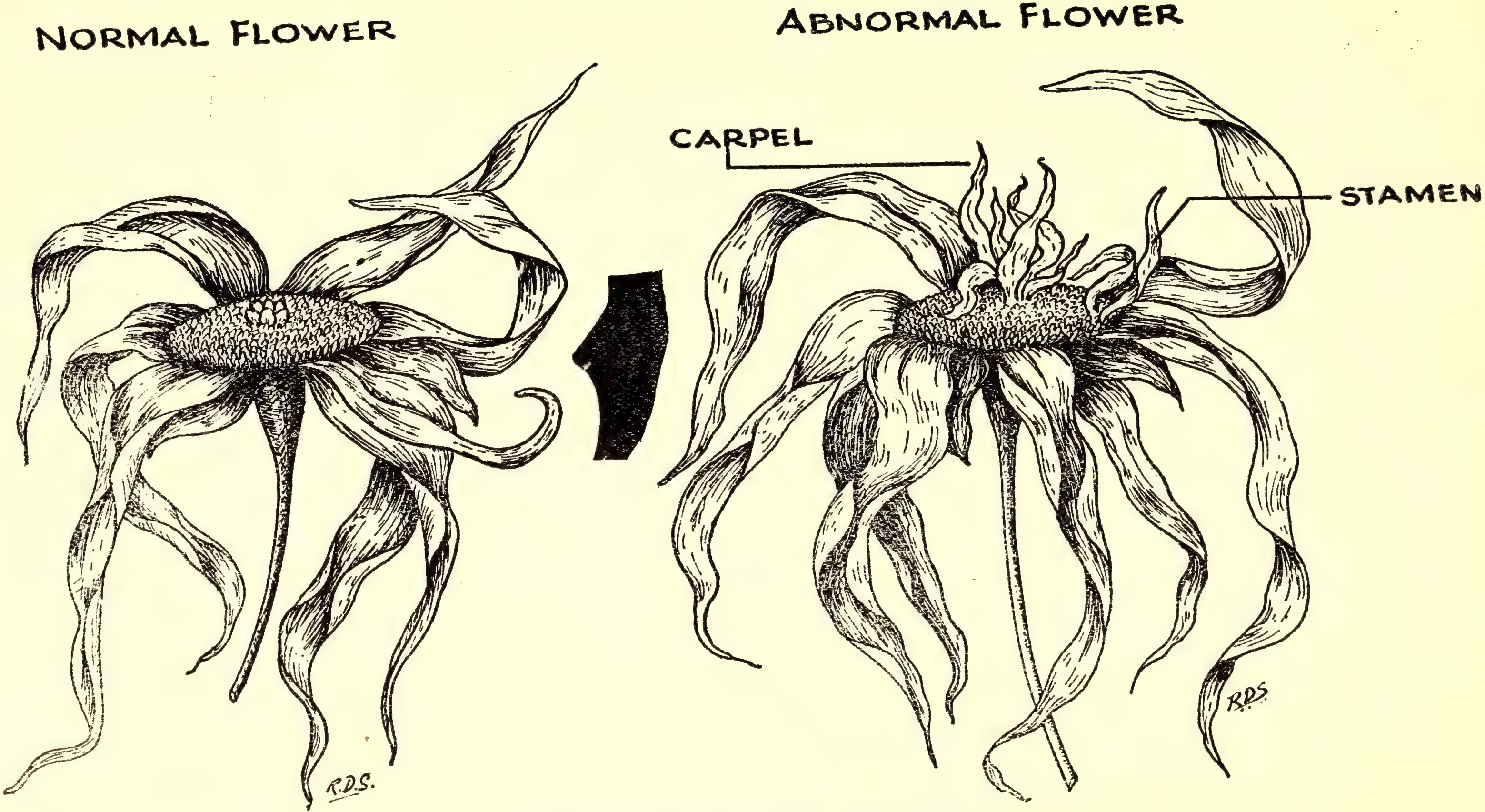
An interesting occurrence of phyllody of the gynoecium and part of the androecium was observed in some flowers of *Cananga odorata* Hook. from the Victoria Gardens, Bombay, in June 1960. Some of the flowers were normal, showing the typical flower of Annonaceae; in some flowers small leaf-like structures were observed in place of the usual free carpels. Both types of flower were collected from the same plant, which appeared to be quite healthy.

Normal as well as abnormal flowers have a calyx consisting of three sepals, which are green, broad, and gamosepalous. The number of petals in the corolla varies in different flowers; smaller flowers have six petals; in larger flowers the number varies from 6 to 12, the more frequent numbers being 7, 8, 9, or 10. The outer petals are bigger, somewhat linear, with an irregularly wavy margin. The petals appear to be folded or twisted, especially in the upper half.

The androecium consists of more than 100 stamens arranged in 5-6 concentric rows on a very slightly elevated, somewhat flat, thalamus. In many flowers it was observed that one or two stamens of the outermost whorl had been transformed into small leaf-like structures. The odd number of petals found in the flowers may be due to one or more of such transformed petaloid stamens being added to the original six segments of the corolla. In such stamens it seems to be the prolonged connective which has been transformed into a leafy structure.

The gynoecium of the normal flower consists of six carpels in which the ovaries and the styles are free, but the stigmas are loosely connected with each other. In abnormal flowers, however, these free carpels have been transformed into leafy structures of varying sizes. Ovules are not developed in these carpels.

Such transformations of the stamens and carpels are common in plants, especially in the Leguminosae. Cooper has reported transformation of carpels and stamens in *Crotalaria striata* DC.; Trivedi & Nigum have reported similar transformation of the stamens in *Bauhinia acuminata* L.; T. C. N. Singh has recorded phyllody in *Trifolium alexandrinum* L., in which some petals, stamens, and gynoecium have been transformed into leaves of various sizes.


NORMAL FLOWER
ABNORMAL FLOWER
CARPEL
STAMEN
R.D.S.
R.D.S.

Phyllody of carpels in *Caranga odorata* Hook.

Recently Mahajan has reported petaloidy of stamens in *Hedychium coronarium* Koenig. Similarly Jayaweera has mentioned petaloid stamens in *Syzygium malacense* Merr. & Perr. From these records it will be noted that phyllody of stamens seems to be more common than phyllody of carpels. The present note is written with the intention of recording phyllody of carpels in *Cananga odorata* Hook., which has so far not been previously mentioned. The fact that this transformation of carpels into leafy structures occurs only in a few flowers in a given plant seems clearly to support the theory that flowers and all their parts are but modified foliage leaves; the facts noted in *Cananga* seem to be but a reversion to ancestral type.

Here we wish to express our gratitude to Rev. H. Santapau, S.J., F.N.I., Director of the Biology Section, St. Xavier's College, Bombay, for critically going through this note and for his suggestions.

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
BOMBAY 1,
August 23, 1960.

(SMT.) K. V. MARATHE
B. S. NAVALKAR

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29. BLACK COLOUR IN FLOWERS: IS THERE SUCH A COLOUR IN NATURE?

In popular literature one often finds references to the black colour of flowers; a correspondent writing in *The Indian Express* of December 2, 1959, mentions that the flowers of the common gram, *Cicer arietinum*, 'grow in four different colours: red, white, yellow, blue or black'.

Sir Robert Robinson (in *Endeavour* **1**: 92, 1942) lists the chief groups of vegetable pigments as (*a*) green chlorophyll and its analogues; (*b*) yellow and orange caritinoids; (*c*) miscellaneous pigments such as are found in fungi; (*d*) yellow anthoxanthins and orange, red, magenta, violet, and blue anthocyanins. Nowhere in the scientific literature is there any mention of black colour for flowers; there may be, and in fact there are in India, a number of plants that turn black on drying; but there is no such thing as a black-coloured flower in the fresh condition.

We have in Bombay several flowers, wild or cultivated, that may have such a deep brown colour as to appear black; such is the case, e.g. in *Iphigenia indica* of our hills, or some of the cultivated Pansies. The flowers are very deep brown when fresh; none of them is truly black.

Among the parasites of the group of *Striga* (fam. Scrophulariaceae) and other parasites, and in e.g. *Ixora nigricans*, the whole plant becomes black when fully dry. Our tea leaves, or the common tobacco leaves, out of which many of the 'stronger' cigars are made, also turn black; but this is due to faulty drying, that is to say, to fermentation in the process of drying. Botany students often find that their green specimens turn more or less deep black, when sufficient care has not been taken during the drying of the specimens.

In a word, there is no black flower as far as my knowledge goes; there may be such deep brown as to appear black at first sight; there may also be real black colour due to faulty dehydration of some specimens; or there may be an over-all black colour in the case of dry parasitic plants. This is as far as black colour goes in plants.

ST. XAVIER'S COLLEGE,
BOMBAY,
December 2, 1959.

H. SANTAPAU, S.J., F.N.I.

30. FOOD FROM GRASS MINUS THE COW

Under the above title, the *Daily Telegraph and Morning Post* of London of May 18, 1959, reports on what has been termed a 'mechanical cow', a machine that extracts proteins from grasses and other green plants. It is well known that proteins are essential for human beings and further that a large part of the population of India suffers from malnutrition, especially from protein deficiency. In other parts of the world sufficient proteins can be obtained from meat, fish, eggs, and milk products; but most of these products are either absent from the diet of the average Indian or at least are supplied in much too small quantities to satisfy the needs of the human body.

Proteins found in grass can to a very small extent be extracted by the cow; experimentally it has been found that only about 5% of the proteins in grass are actually extracted by cows. Such proteins are made available to us in meat and milk. But in the present condition of food shortages, it is almost criminal to allow 95% of the proteins in grass to go waste.

The 'mechanical cow' has been set up at Rothamsted Experimental Station; the machine is able to extract at least 50% of the proteins in grass. The Science Correspondent of the *Daily Telegraph* writes on the working of the machine: 'When I saw it this week it was consuming rye. From a normal elevator this was fed into a chopping machine. The chopped rye then entered a press and the juice was squeezed out of it. This juice, which contains the bulk of the protein and hardly any of the cellulose, is then treated with steam: the object being to precipitate the protein. When the protein is precipitated, or made solid, it only requires a filtering process to retain the protein and let all the unwanted juice pass through. Within a very few minutes the 'cow' has produced solid, cake-like protein from green leaves and, what is more important, has collected at least 50 per cent of the protein in the leaves. Moreover, both the juice-less rye choppings and also the waste juice from the filters are still good feeding stuff for animals.'

This is certainly an interesting development. India can ill afford to waste any fodder; under the best conditions, according to the statement made a few years ago by the Director, Animal Husbandry Dept., Govt. of India, the country has enough fodder for scarcely one half of its cattle, if the latter is to be fed properly. The new method does not reduce the quantity of fodder available for cattle, but makes better use of the same.

C/O LLOYDS BANK LTD.,
39, PICCADILLY,
LONDON W. 1,
December 2, 1959.

R. W. BURTON
Lt.-Col., I.A. (Retd.)

Gleanings

Longevity in Wild Birds

The following records of longevity in birds reproduced from page 214 of *The Ring*, Vol. 22, February 1960, may be of interest :

Numenius arquata—Curlew : Ringed as a pullet on 4-7-1926 in Sweden, recovered on 25-1-58 in Great Britain, age 31 years 6 months 21 days.

Milvus milvus—Kite : Ringed as a pullet on 19-6-30 in Switzerland, recovered on 15-3-1956 in France, age 25 years 8 months 24 days.

Locusts as a Delicacy

‘ For the first time since we had arrived in the Tassili we saw some flights of locusts. The insects were not very numerous, but they rejoiced the hearts of our Tuareg, who at break of dawn set out to catch the creatures on the trees where they had alighted. It was manna from heaven, for one and all the inhabitants of the Sahara, whether they be Arab, Tuareg or ‘ Moor ’, enjoy a meal of fried locusts.

‘ Matal and Agaoued, who had gone off to see the donkeys grazing, brought back one morning a sackful of locusts which they at once threw living upon hot cinders. A locust, at least to our French palates, is not really what you call a titbit, but for men who are always hungry and whose usual fare is lizards and small rodents, locusts make a very acceptable meal. When a locust is fried or grilled its legs are pulled off (for these are set with prickles), and as much of the wings as has not been consumed by the fire is removed. The head is wrenched off at the same time and the digestive tube extracted for this is quite uneatable on account of the green matter it contains. The rest of the insect is then munched much in the way that we eat shrimps. Sometimes the Tuareg reduce the grilled locusts to powder and place it in skin sacked (*mezwed*) so that it can be eaten, with the addition of water or milk, when the men are travelling.

‘ I myself rather like locusts and at times have eaten nothing else for weeks, but I am free to admit that the taste is not to everyone’s liking. It seems, however, that the really smart thing to do now in the Ourgla oasis—where the oil-men forgather—is to serve grilled locusts (at five francs apiece !) with the *apéritifs*. Maybe a rather expensive bit of snobbery, but one that certainly does provide plenty of local colour.

‘ All the members of the team wanted, of course, to sample the locust. Each one of them gave his opinion. Michel Brézillon thought they tasted like cardboard. Vila compared them with nuts. Lajoux said they reminded him of grass. I maintained they had a savour of shrimps, while Guichard made a grimace and spat out the insect after a vain attempt to swallow it. For him, it was for all the world like excrement.’

Henri Lhote : THE SEARCH FOR THE TASSILI FRESCOES : THE STORY OF THE PREHISTORIC ROCK-PAINTINGS OF THE SAHARA. Translated from the French by Alan Houghton Brodrick. (Hutchinson of London, 1959)

A New Method of Insect Control

Over the last few years many attempts at insect control have been made in India by the use of DDT and other chemical poisons. Malaria has been eliminated over large areas but many other insects besides mosquitoes have been destroyed at the same time and the consequent ecological changes may lead to untoward results which were not foreseen.

Interest will therefore be felt, not only in India but all over the world, in a revolutionary method of insect control, which has given successful results in the United States. The screw-worm fly (*Callitroga hominivorax*) is found in large areas of the southern states of the Union. The adults lay eggs in open wounds in large and small mammals and the maggots produce conditions which attract more flies and eggs, finally leading to the death of the infected animal unless treated by man.

The U.S. Department of Agriculture and the Florida Livestock Experimental Board raised millions of screw-worm flies under factory conditions, where they were fed on horse and whale meat and then rendered sexually sterile by gamma rays from a Cobalt-60 source. These flies when sexually mature were released over the insect-infested areas (70,000 sq. miles) in Florida from aeroplanes. The behaviour of both males and females was unchanged but the effect upon the population of screw-worm flies was greater than anticipated. Within a year after the initiation of the programme the insect was eradicated, and ‘ not a single screw-worm fly has been seen in the southeastern U.S. for almost two years ’. This method has many advantages over the usual control technique. It is effective only on the species concerned. The insects do not acquire immunity to sterile matings as they do to insecticides. In addition to this, when poison is used, it becomes less efficient as the population declines and is left in isolated pockets ; the few survivors can then again build up the population in geometric progression. The sterile male increases the overall effectiveness of the attack and becomes more effective on a restricted population.

Any problem of this kind requires a large amount of preliminary work as well as co-ordinated working at a later stage, but the results are so effective that this method of insect control is superior to any other method of insect control devised so far.

Our information is derived from an excellent article on the eradication of the screw-worm fly by Edward F. Knipling at pages 54-61 of *Scientific American* for October 1960.

Notes and News

The Thirteenth International Ornithological Congress will be held at Cornell University, Ithaca, New York, U.S.A., from 17 to 21 June 1962. The President is Professor Ernst Mayr.

The International Ornithological Congresses are scientific meetings which have been held at intervals since 1884. Since 1926 a four-year cycle has been maintained except for a twelve-year interruption caused by World War II. The previous Congresses have been held in continental Europe and England.

Persons wishing to receive further announcements, and membership application forms for the Thirteenth International Ornithological Congress should send their names and permanent mailing address to the Secretary-General, Professor C. G. Sibley, Fernow Hall, Cornell University, Ithaca, New York, U.S.A., before 1 February 1962.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1959-60

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Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1959-60

At the last Annual General Meeting held on 31st August 1959 I presented a supplementary report up to that date. Except for the references to the *Journal* and the revenue account, this report deals with the period of one year since then.

THE SOCIETY'S JOURNAL

Volume 56 of the *Journal*, publication of which was completed in the year under report, contained 34 articles and 84 miscellaneous notes. We have to express concern that it is becoming more and more difficult to obtain material relating to matters of natural history.

GENERAL

The negotiations with the Central Government regarding a block grant for the construction of a building for the Society in the Prince of Wales Museum grounds in Bombay have not yet been finalized. Plans have, however, been prepared. The building when completed will have over 14,000 sq. ft. of floor space including a lecture room (1160 sq. ft.), rooms for reference collections (6615 sq. ft.), and a laboratory and work room (1160 sq. ft.). The plans and estimates have been forwarded to the Ministry of Scientific Research & Cultural Affairs, and it is hoped to finalise negotiations and commence building at an early date.

The funds made available by the Rockefeller Foundation, referred to in the supplementary report last year, have been usefully expended. In addition to a second bird-banding project in Kutch, 18 grants to the extent of about Rs. 5700 were made for various problems, botanical and zoological ; some of the results will be published in our journal in due course.

The first bird migration camp in Kutch referred to in the last report was supplemented by a small grant from the World Health Organization. This made it possible to obtain the advice and assistance of Dr. A. Schifferli, Director of the Swiss Migration Centre at Sempach, who visited India particularly to assist in the field. A second camp was established at Kuar Bet on the borders of the Rann of Kutch for the spring migration. Subsequent to this the World Health Organization have made a grant of $ 8000.00 to continue this work with a view to investigating the relationship between the movements of birds and the spread of virus diseases.

In my last report I referred to the indexing of the books in our library. This work has now been completed, and a grant from the Government of Maharashtra has enabled us to purchase a sufficient number of cabinets to hold all our books. 201 new books have been added to the library during 1959 and the current year up to 31st August. These include 74 purchased, 114 presented, and 13 received for review.

Over the same period about 500 birds and 100 reptiles and amphibians have been added to our collections. They include, among birds, the type of a newly described race, *Dumetia hyperythra navarroi,* several Finn's Bayas (*Ploceus megarhynchus*) whose re-discovery in the wild I referred to in my last report, and a pair of Godwin-Austen's Hornbills [*Ptilolaemus tickelli austeni* (Jerdon)]. The identified reptiles include specimens of the little known species *Barkudia insularis* of Annandale from Waltair, and *Platyurus platyurus* from Nepal, and the amphibians *Rana afghana*, tadpoles of *Megalophrys* sp. from Nepal, *Bufo andersoni* from Kutch, and *B. latastii* from Kashmir, which are all new additions to our collection. Other rarities and interesting specimens will no doubt be discovered when the collections have been more fully worked out.

With the funds made available by the State Government, orders have been placed for steel cabinets to house the birds and mammals in our collection. It is hoped that when these come in and the specimens are suitably transferred to them, the large collections will be more easily accessible and more work will be done thereon.

During the year, Dr. (Miss) Rachel Reuben delivered an interesting talk on ' Insects and Weather ' and Mr. Leslie Brown showed a coloured movie film accompanied by a talk on ' Eagles '.

PUBLICATIONS

Unfortunately, we have not been able to make much progress with the new editions of the Animal and Bird books. Work has been held up mainly by financial difficulties and we are negotiating with the Ministry of Scientific Research & Cultural Affairs for a grant in this connection. The text and pictures of both the books are ready and it is hoped that the negotiations will be completed shortly and that it will be possible to have them ready at an early date. Dr. Dillon Ripley's A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN is in the last stages of printing and we hope to publish it in a couple of months.

NATURE EDUCATION

The Nature Education Scheme, financed by the Government of Bombay, is now in its 12th year. Tours of the Natural History Section of the Prince of Wales Museum and special talks on natural history subjects with the aid of exhibited and other specimens, films, and some living animals were continued. Over 4500 children were lectured to.

Nine field-trips were arranged for members of Nature Study Clubs in schools, to different places in the island of Salsette and one to Nirmal Lake near Bassein. The trips are followed by meetings (44 held this year) at schools to help children to collect and preserve specimens and to discuss topics of natural history interest.

Two field-trips for teachers were arranged, one led by Fr. H. Santapau, S.J., to Tansa Lake to study the plants, and the other covering geology by Dr. R. N. Sukheshwala to Elephanta Island.

The fourth booklet OUR MONSOON PLANTS in the series ' Glimpses of Nature ' was published. Though these booklets are available in English, Hindi, Marathi, and Gujarati and are very much appreciated by educationists, their sale is comparatively poor, and the stock in hand renders difficult the publication of additional numbers. The fifth, OUR ANIMALS, is almost ready and should be soon available.

A meeting of children to celebrate Wild Life Week was held on 7th October 1959, and some films were shown.

REVENUE ACCOUNT

In the last report I referred to a total membership of 1255 as at the end of 1958 and stated that 274 members had either not paid their subscriptions or could not be traced. Efforts were made to ascertain their whereabouts and, in the absence of any response, we had to remove from the membership rolls the names of 328 members at the end of 1959, including 38 who resigned and 11 who died during the year. With the addition of 88 new members the register as at the end of 1959 showed a total membership of 1058. Efforts are being made to enrol more new members by the distribution of a brochure depicting the history and activities of the Society, which we have been able to produce with the funds made available by the grant received from the Rockefeller Foundation.

During the year under review the income of the Society rose to Rs. 57,657.40 as against Rs. 47,374.00 in the previous year. This was mainly due to a grant of Rs. 8000.00 having been received from the Government of India. During the year the Society ran out of stock of two of its most popular publications and this resulted in a drop in income from this source by approximately Rs. 2010.72 which we were largely able to make up from other sources of revenue.

The operations of the Society during 1959 showed a deficit of Rs. 2221.00 as against Rs. 11,448.00 in 1958. A promised recovery of Rs. 3155.00 from the Prince of Wales Museum in respect of half the salary of the Acting Curator, referred to in the last report, has now been made and has been adjusted towards last year's deficit of Rs. 11,448.00 thus reducing the deficit for that year to Rs. 8293.00. Had it been possible to secure the Government of India grant of Rs. 8000.00 in respect of 1958, the deficit would have been reduced to Rs. 293.00 only and attempts are still being made to secure this grant.

Expenses during the year amounted to Rs. 59,878.89, an increase of Rs. 1056.75 over the previous year. The increase is chiefly attributable to the cost of shifting the reference collection from the Museum to our premises and travelling expenses paid for interviewing candidates for the post of Curator, both non-recurring items of expenditure.

Of course, the appointment of a Curator will mean an additional expenditure of approximately Rs. 10,000.00 in 1961 but the Executive Committee is actively considering ways and means of increasing the Society's income to meet this expense.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

ACKNOWLEDGEMENTS

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in the United Kingdom.

THE BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT 31 DECEMBER 1959

FUNDS AND LIABILITIES		Rs nP	Rs nP
Trust Fund or Corpus:			
Life Membership Fund:			
Balance as per last Balance Sheet ...		97,340.28	
Add: Amounts received during the year...		150.00	
			97,490.28
Other Earmarked Funds:			
Field Work Fund:			
Balance as per last Balance Sheet	2,909.97		
Less: Spent during the year...	950.00		
		1,959.97	
Expedition Fund ...		1,800.00	
Wild Life Fund ...		715.25	
Mammal Survey Fund:			
Balance as per last Balance Sheet	3,265.73		
Less: Spent during the year ...	194.09		
		3,071.64	
Building Fund ...		30,000.00	
Nature Education Trophy Fund ...		500.00	
Reserve for Wall Snake Charts ...		3,000.00	
Unspent Grant of Government of Bombay:			
Balance as per last Balance Sheet	33,515.43		
Less: Spent up to 31.3.59 ...	16,860.85		
	16,654.58		
Less: Spent for equipment & Furniture after 31.3.59 ...	480.29		
	16,174.29		
Add: Transferred from Income and Expenditure Account	11,656.83	27,831.12	68,877.98
Carried forward ...			1,66,368.26

ASSETS	Good	Doubtful	Rs nP	Rs nP
Immovable Properties				nil
Investments: (At cost) ...				
Rs. 14,000 4% Bombay Port Trust Bonds			10,780.00	
,, 15,000 4% Bombay Improvement Trust Bonds ...			11,400.00	
,, 36,000 3% Funding Loan 1966-68 ...			35,812.62	
,, 25,000 3% Conversion Loan 1946 ...			25,000.00	
,, 2,000 3% First Development Loan 1970-75 ...			1,948.75	
,, 92,000 (Market value Rs. 83,785)			84,941.37	
£ 460 3½% Defence Bonds			6,133.34	
			91,074.71	
Less: Provision for Depreciation ...			3,750.00	87,324.71
Furniture and Fixtures:				
Balance as per last Balance Sheet ..			1,441.49	
Less: Sold during the year			350.80	
			1,090.69	
Add: Addition during the year ...			103.15	
			1,193.84	
Less: Depreciation during the year ...			145.68	1,048.16
Loans: (Secured)				
Loan Scholarships	nil	nil		
Other Loans (to staff) ..	248.39	nil		248.39
Advances:				
To Trustees			nil	
,, Employees			nil	
,, Contractors			6,859.30	
,, Lawyers			nil	
,, Nature Education Scheme			965.64	
,, Others			121.29	7,946.23
Income Outstanding:				
Rent			nil	
Interest (Accrued)			1,349.13	
Other Income:				
Supplies and Services			10,700.72	
Government of Bombay Grant			4,000.00	
Carried forward ..			16,049.85	96,567.49

BALANCE SHEET AS AT 31 DECEMBER 1959—(*continued*)

FUNDS AND LIABILITIES		Rs nP
Brought forward ...		1,66,368.26
Unspent Grant from Rockefeller Foundation		31,454.42
Liabilities:		
For Expenses	27,443.53	
,, Advances (Subscriptions) ...	1,359.71	
,, Sundry Credit Balances ...	4,540.38	33,343.62
Income and Expenditure Account		
Balance as per last Balance Sheet	26,650.69	
Add: Refund of Mr. V. K. Chari's salary in respect of 1958	3,155.63	
	29,806.32	
Less: Deficit as per Income and Expenditure Account	2,221.49	27,584.83
Total ...		2,58,751.13

ASSETS	Rs nP	Rs nP
Brought forward ...	16,049.85	96,567.49
Government of India Grant	8,000.00	
Government of Bombay Special Grant ...	34,000.00	
Rockefeller Foundation Grant	2,845.11	60,894.96
Stock of Books on hand: (At cost or under) As certified by the Honorary Secretary ...		54,028.17
Cash and Bank Balances:		
(*a*) *In Current Account with:*		
National and Grindlays Bank Ltd., Bombay	8,215.92	
National and Grindlays Bank Ltd., London	8,494.59	
Fixed Deposit with the Comptoir National d'Escompte de Paris,	30,000.00	
(*b*) With the Trustee		
(*c*) With the Cashier	550.00	47,260.51
Total ...		2,58,751.13

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Properties and Assets of the Trust.

(Sd.) (Fr.) H. SANTAPAU,
Trustee.

As per our report of even date.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

BOMBAY, 10*th May*, 1960.

THE BOMBAY NATURAL HISTORY SOCIETY

SEPARATE ACCOUNTS

1. GOVERNMENT OF BOMBAY SPECIAL GRANT ACCOUNT EXPIRING ON 31.3.1960

Cr.	Rs nP	Dr.	Rs nP
To Rent for 9 months from 1.4.59 to 31.12.59 ...	15,750.00	By Grant for 1959-60	34,000.00
,, Salaries from 1.4.59 to 31.12.59	6,447.61		
,, Miscellaneous expenses from 1.4.59 to 31.12.59 ...	145.56		
,, Balance unspent transferred to Balance Sheet ...	11,656.83		
Total ...	34,000.00	Total ...	34,000.00

2. ROCKEFELLER FOUNDATION GRANT FOR 1959-60

Cr.	Rs nP	Dr.	Rs nP
To Contribution to B. N. H. S. Library for book-binding	3,332.20	By Grant ($10,000)	47,000.00
,, Contribution to B.N.H.S. Library for purchase of new books	1,800.00		
,, Bird Migration study expenses at Kutch ...	8,102.68		
,, Field grants to various members	2,310.70		
,, Balance unspent transferred to Balance Sheet ...	31,454.42		
Total ...	47,000.00	Total ...	47,000.00

3. WORLD HEALTH ORGANISATION GRANT

Cr.	Rs nP	Dr.	Rs nP
To Bird Migration study survey expenses at Kutch ...	4,718.79	By Grant ($1,000)	4,718.79
Total ...	4,718.79	Total ...	4,718.79

4. Library Account

Cr.	Rs nP	Dr.	Rs nP
To Purchase of New Books	2,701.36	By contribution from Rockefeller Foundation Grant Account No. 2	5,132.20
,, Subscription to other Societies	677.81	,, Miscellaneous receipts	700.54
,, Book binding expenses	3,332.20	,, Transferred to Income and Expenditure Account ...	878.63
Total ...	6,711.37	Total ...	6,711.37

5. Journal Account

Cr.	Rs nP	Dr.	Rs nP
To Cost of printing Journal	17,209.11	By Grant from the Government of India	8,000.00
		,, Transferred to Income and Expenditure Account	9,209.11
Total ...	17,209.11	Total ...	17,209.11

6. Publication Account

Cr.	Rs nP	Rs nP	Dr.	Rs nP
To opening stock on 1.1.1959 ...	53,411.16		By Sales during the year	35,255.24
,, Additions during the year ...	20,673.00		,, Closing stock on 31.12.1959	54,028.17
		74,084.16		
,, Royalties to Authors		2,451.61		
Transferred to Income and Expenditure Account		12,747.64		
Total ...		89,283.41	Total ...	89,283 41

7. Miscellaneous Account

Cr.	Rs nP	Dr.	Rs nP
To Expenses for shifting reference collections from Museum to Society's premises	1,190.97	By Transferred to Income and Expenditure Account ...	1,943.45
,, Travelling expenses for interviewing candidates for Curator's post	552.13		
,, Contributions to Scientific Organisations ...	200.35		
Total ...	1,943.45	Total ...	1,943,45

8. ESTABLISHMENT ACCOUNT

Cr.	Rs nP	Dr.	Rs nP
To Salaries including Dearness Allowance ...	21,774.80	By Transferred to Income and Expenditure Account ...	34,014.96
,, Contribution to Staff Provident Fund ...	1,362.48		
,, Postage	1,549.53		
,, Printing and Stationery	1,178.33		
,, Advertisement	123.97		
,, Editors' travelling allowance	1,050.00		
,, Travelling allowance to Honorary Secretary ...	3,600.00		
,, Telephone call charges	461.42		
,, Bank charges	251.42		
,, Audit Fees	512.85		
,, Fire Insurance	157.32		
,, Depreciation on Furniture	145.68		
,, Field travelling expenses	47.88		
,, General charges	1,799.28		
Total ...	34,014.96	Total ...	34,014.96

INCOME AND EXPENDITURE ACCOUNT

Cr.	Rs nP	Dr.	Rs nP
To Journal Account No. 5	9,209.11	By Publication Account No. 6	12,747.64
,, Library Account No. 4	878.63	,, Grant from the Government of Bombay ...	4,000.00
,, Miscellaneous Account No. 7	1,943.45	,, Membership Fees	21,573.15
,, Establishment Account No. 8	34,014.96	,, Entrance Fees	440.00
		,, Interest on Investments	5,019.86
		,, Commission on taxidermy work	44.01
		,, Deficit transferred to Balance Sheet	2,221.49
Total ...	46,046.15	Total ...	46,046.15

THE BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

RECEIPTS

	Rs nP
To Bank Balance on 1.1.1959	1,088.75
,, Government of Bombay Grant for 1958-59 ...	6,100.00
,, Government of Bombay Grant *re* increment in salary	1,080.00
,, Sales of Booklet No. I	332.55
,, Sales of Booklet No. II	379.58
,, Sales of Booklet No. III	525.56
,, Sales of Booklet No. IV	259.95
,, Sales of line drawings	32.36
,, Loan from Bombay Natural History Society ...	965.64
Total ...	10,764.39

PAYMENTS

	Rs nP
By Re-payment of loan from Bombay Natural History Society	2,004.11
,, Salary of Nature Education Organiser ...	5,875.00
,, Postages	72.25
,, Cost of Printing Line drawings	25.20
,, Cost of Booklet No. II	70.00
,, General charges	392.23
,, Printing and stationery	114.44
,, Cost of Booklet No. III	1,057.10
,, Cost of Booklet No. IV	1,071.55
,, Cash on hand with the cashier	50.00
,, Bank balance on 31 December, 1959	32.51
Total ...	10,764.39

Bombay, *10th May, 1960.*

(Sd.) A. F. Ferguson & Co.,
Chartered Accountants

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE DURBAR (TOWN) HALL, BOMBAY, ON WEDNESDAY, 12TH OCTOBER 1960, AT 6 P.M., WITH REV. FR. H. SANTAPAU, S.J., IN THE CHAIR

1. The Honorary Secretary's Report for the years 1959-60, having been circulated among members prior to the meeting, was taken as read, and was adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Treasurer were approved.

3. The Chairman referred to the recent death of Dr. S. P. Agharkar who was a member of the Society for many years and served on the Executive Committee from 1954 to the date of his death.

A resolution of condolence, to be conveyed to Mrs. S. P. Agharkar, was adopted with all members standing.

4. Dr. Sálim Ali then delivered a talk illustrated by a film on the Bird Migration Studies which are being carried out with funds made available by the World Health Organisation and in collaboration with the Virus Research Centre, Poona. The talk and the film were greatly appreciated.

5. The meeting terminated with a vote of thanks to Dr. Sálim Ali for his talk, to the Asiatic Society for the loan of the premises, and to the Chairman of the meeting.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—5-1-1961. C4964
EDITORS: H. SANTAPAU & HUMAYUN ABDULALI

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and monochrome plates. 2nd (revised) edition. *(In preparation)*

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sálim Ali. With 64 coloured and many monochrome plates, 6th edition, revised and enlarged. *(In preparation)*

Fishes

Circumventing the Mahseer and Other Sporting Fish in India and Burma, by A. St. J. Macdonald. With coloured and monochrome plates. **Rs. 15**
(*Price to Members Rs.* 12)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. Rs. 10
(*Price to Members Rs.* 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to Members Rs.* 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text figures. **Rs. 6**
(*Price to Members Rs.* 4.50)

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1. OUR BIRDS I (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **80 nP**
   Kannada **62 nP**
2. OUR BIRDS II (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **62 nP**
3. OUR BEAUTIFUL TREES (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **62 nP**
4. OUR MONSOON PLANTS (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **80 nP**
5. OUR ANIMALS (with 8 coloured plates) in English. *(In preparation)*

Back numbers of the Society's Journal. Rates on application.

Obtainable from :

The Honorary Secretary,
Bombay Natural History Society,
91, Walkeshwar Road, Bombay 6.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the Journal, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postage—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

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THE LIBRARY SMITHSONIAN INSTITUTION

SMITHSONIAN INSTITUTION LIBRARIES
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